Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

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JULY, 1947

EAN
ENGINEERING
Company, Inc.
WARREN, OHIO

SPECIALISTS IN
SHEET, TIN & STRIP
MILL EQUIPMENT

WEAN
EQUIPMENT
Corporation
Cleveland Ohio

NARROW STRIP
AND WIRE MILL
MACHINERY

HOLMQUIST
BARBED WIRE
AND
WIRE FENCE
MACHINERY

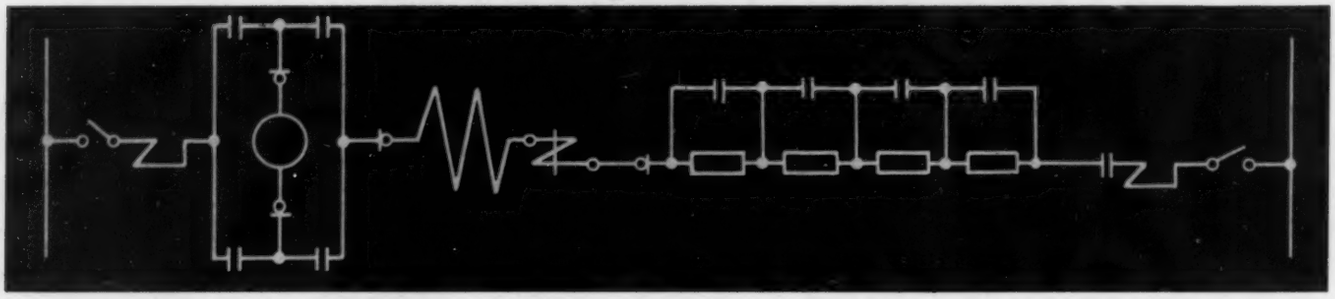
R v.24² July-Dec. 1947

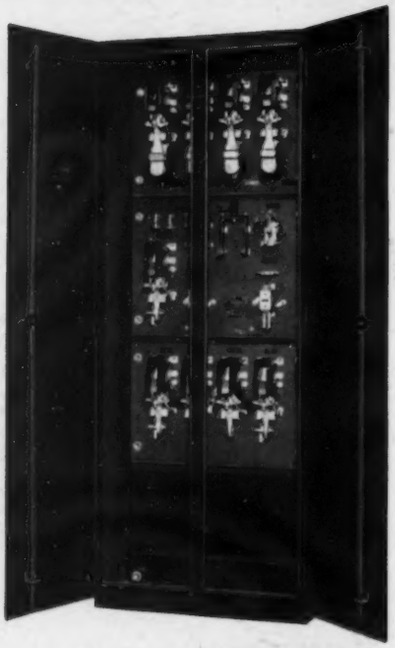
What control for what mill equipment?

One of a SERIES

of advertisements featuring basic heavy duty power circuits . . . and showing Cutler-Hammer's broad design and application experience which has made it the preferred control for the steel industry.

When you have a crane application that calls for accurate stopping of bridge and trolley . .





CHECK these mechanical components as well

Then ask for Cutler-Hammer No. 14111

D. C. Reversing Plugging Control

with Rectifier Plugging

Cutler-Hammer engineers have designed this simple, rugged mill control for series wound motors that drive crane bridge and trolley or other equipment that must be stopped and reversed frequently, rapidly and accurately.

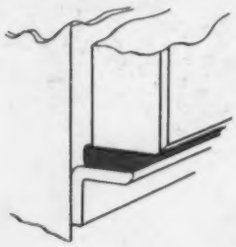
Besides using the well-known C-H *Ltl* Inductive Time Limit acceleration, this control employs rectifier plugging for fast, accurate stops. The master inherently provides several operating speeds with speed reduction up to 50%. An optional, low creeping speed can also be supplied.

Mill maintenance men like Bulletin 14111 because of its ruggedness and simplicity of design. They also like the mechanical features, a few of which are shown below.

Dependable 14111 is the product of long years of diversified Mill Control experience. . . . . CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

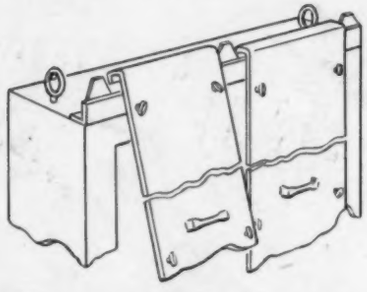
CUTLER-HAMMER
MOTOR CONTROL
C-H

Shock-proof frame



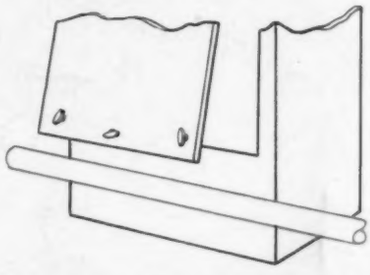
An important detail is the C-H Shock-Proof Frame. Here, special angles, welded to the frame support each Unit Panel on a resilient mounting base.

Easy-on, easy-fasten back plate



Back plate hooks on at top and is self-aligning. With this and captive wing nuts, maintenance men find it easy to remove.

Shaft-clearing short back plate



Another feature mill men like is the C-H short back plate that clears the crane bridge drive shaft.

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Tech.

Specialists...

IN IRON-BASE ROLLS

● The one profitable test for mill rolls is — tonnage produced per roll.

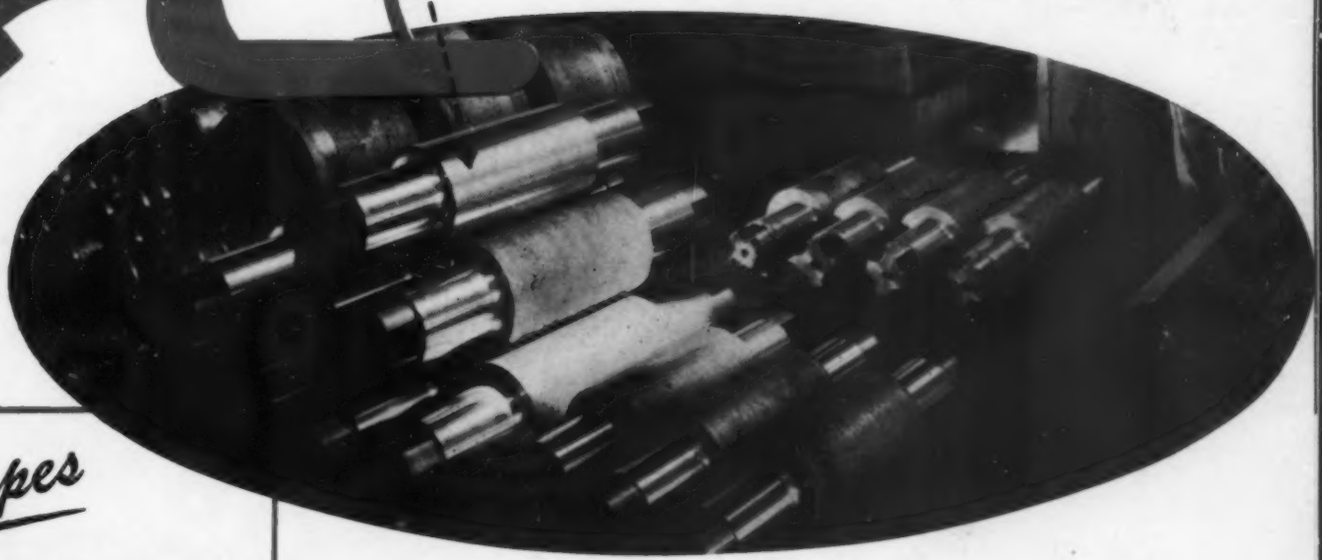
As specialists in iron-base rolls, Aetna-Standard has an impressive list of users and testimonials of performance. These rolls have built up an outstanding record of low cost per ton.

Your experience dictates which rolls are producing the most tonnage. Our 35 years' experience guides us in recommending the right analysis and type of roll for your specific job.

When you buy from Aetna-Standard, you are doing business with an engineering company which specializes in iron-base rolls, seamless tube mills, continuous butt weld pipe mills, coating equipment, and flat-rolled finishing equipment.

Aetna-Standard makes iron-base rolls for bar, billet, tube, rod, sheet and strip, and plate mills.

Call on the specialists for your rolls.



Types

Sizes — from rolls for an 8-inch mill, all intermediate sizes up to large plate mill rolls, 34" x 206".

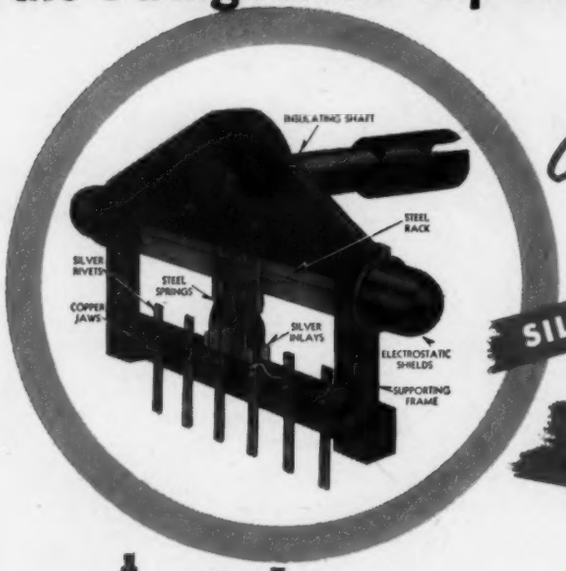
Plain Chill	Alanite A-B-C-D
Sand Iron	Asex Grain
Moly Chill	Asex Special
Nickel Chill	

THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

ASSOCIATED COMPANY: HEAD, WRIGHTSON & CO., LTD., MIDDLESBROUGH, ENGLAND

Only in a PENNSYLVANIA TRANSFORMER do you get the Straight Line Tap Changer with Silver Alloy Contacts



All you want in a Tap Changer and More!

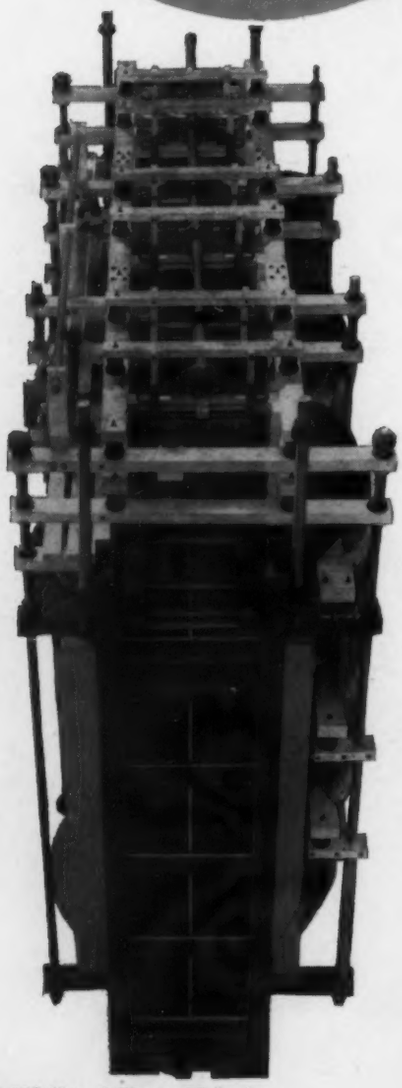
SILVER ALLOY CONTACTS

SELF-ALIGNING CONTACTS

SIMPLE IN DESIGN

RELIABLE IN CONSTRUCTION

WILL NOT FREEZE IN POSITION



20,000 Kva, 3 Phase, 25 Cycles, OISC, 44000-6600 volts.

Arrangement of tap changers on 3 phase, transformer. Note that all 6 tap changers are operated by a single shaft.

Gives Pennsylvania Power Transformers Unsurpassed Reliability . .

★ ***NO HOT SPOTS***

Silver alloy contacts are capable of carrying heavy overloads and withstanding short circuits without overheating because of low initial contact resistance.

★ ***DURABLE***

Hardness of silver contacts prevents harmful wear, even under continuous operation such as in a motor-operated tap changer. Contacts are installed with a minimum of flat surface at the contact points to prevent the accumulation of sludge. Silver alloy contacts will never freeze in position.

★ ***EASY TO OPERATE***

The direct connection of the shaft to the gear and use of a minimum number of bearings, plus the application of low friction, silver alloy contacts, result in a very low torque and an easy to operate tap changer.

★ ***SELF-ALIGNING***

Pennsylvania Tap Changers possess a self-aligning feature which assures a high pressure contact at all times. This is accomplished by the special steel spring construction and straight-line motion of the movable jaw.

★ ***CORONA ELIMINATED***

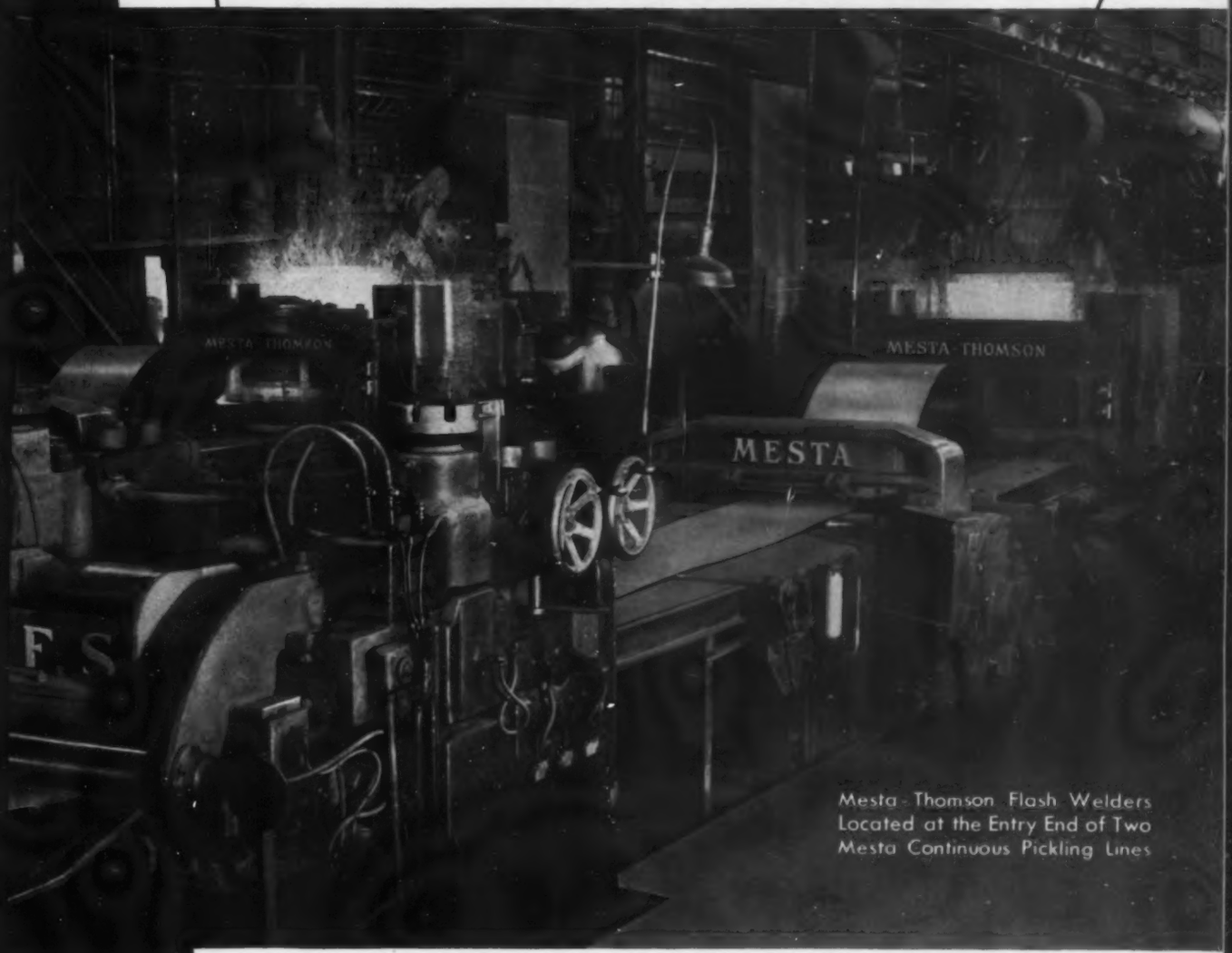
In higher voltage tap changers the elimination of corona is very important. This is accomplished in Pennsylvania Tap Changers by electro-static shields of spun copper connected to the live parts of the tap changer. Discharges due to corona are thus prevented.

Pennsylvania TRANSFORMERS

Pennsylvania
TRANSFORMER COMPANY
808 RIDGE AVENUE, PITTSBURGH 12, PENNSYLVANIA

Increase...

COLD MILL PRODUCTION *with* MESTA-THOMSON FLASH WELDERS



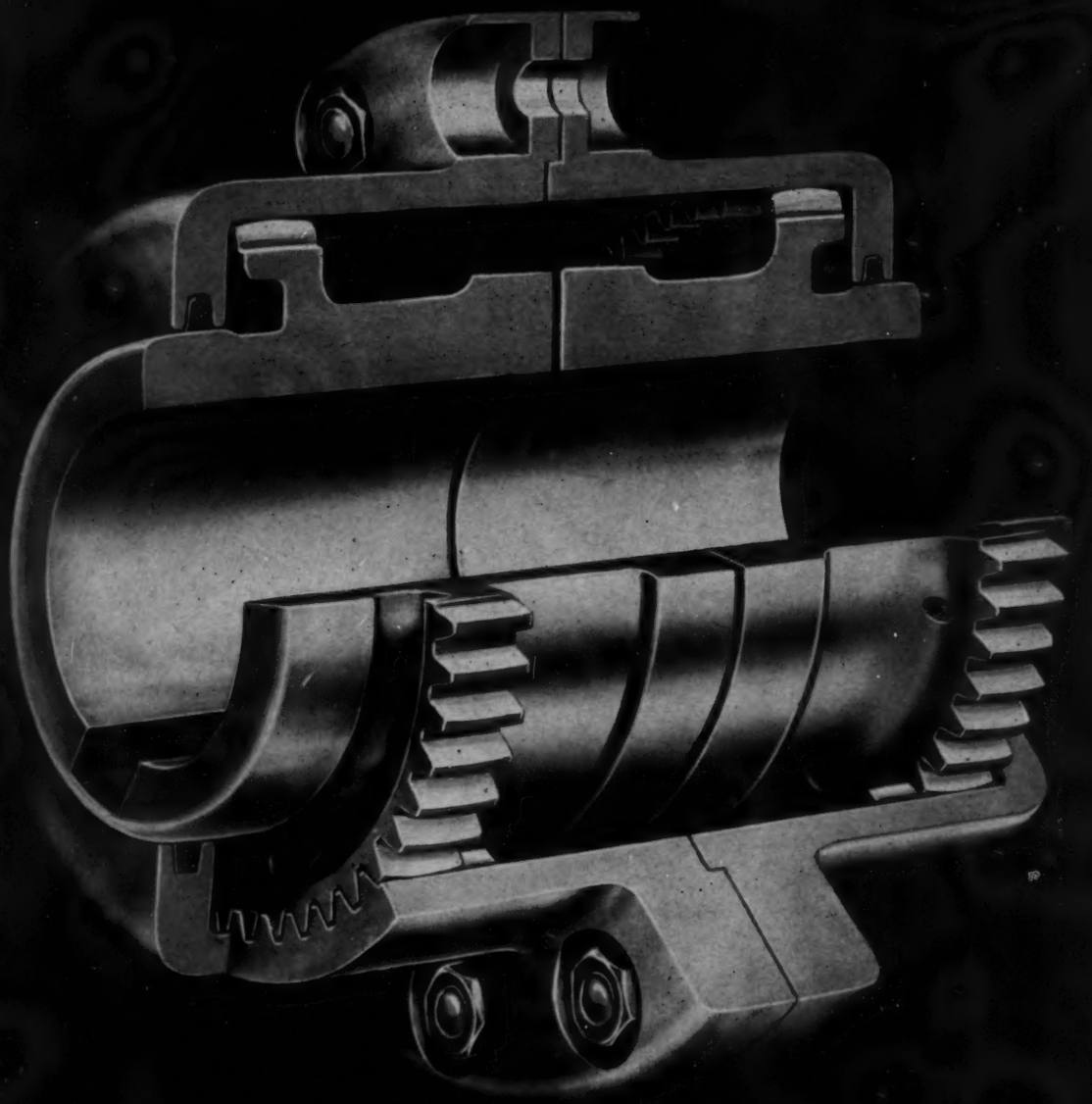
Mesta-Thomson Flash Welders Located at the Entry End of Two Mesta Continuous Pickling Lines

Cold mill production is increased when MESTA-THOMSON FLASH WELDERS are installed in your continuous pickling lines. They produce heavier coils, with butt-welded joints, suitable for cold rolling on today's high speed mills.

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE CO. PITTSBURGH, PA.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

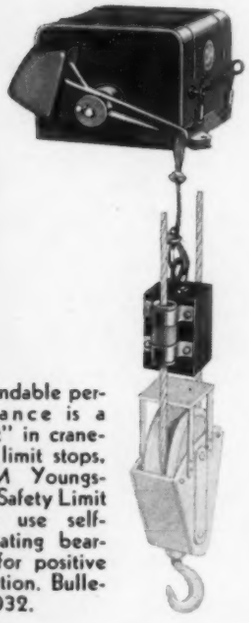
POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

HEAVY-DUTY
Self Lubricating Bearings

The costly and sometimes forgotten item of lubricating maintenance is eliminated forever in this EC & M Equipment

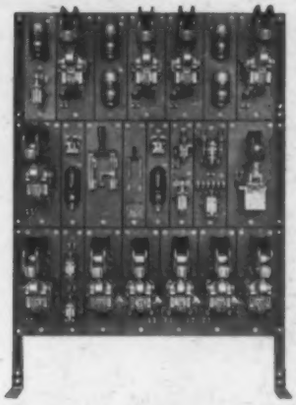
FOR many years, steering-post columns of passenger automobiles have been equipped with self-lubricating bearings for long life and ease of manipulation at any speed. EC&M products have likewise been improved with these modern bearings, eliminating forever the problem of lubrication and resulting in lower maintenance costs and years of dependable performance. Other EC&M products, than those here shown, also use self-lubricating bearings where no leakage can be tolerated and where an oil cushion bearing, causing an oil-film to be generated wherever needed, is an important asset. As a leader in improvements in control design and control apparatus, EC&M was one of the first to use self-lubricating bearings.



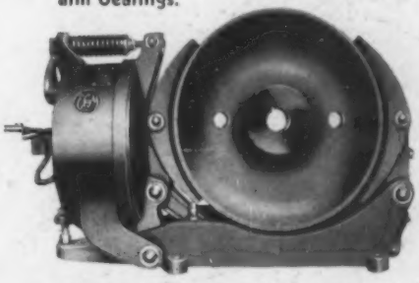
Dependable performance is a "must" in crane-hoist limit stops. EC&M Youngstown Safety Limit Stops use self-lubricating bearings for positive operation. Bulletin 1032.

Lower Maintenance Advantages of these Self Lubricating Bearings

1. Reduced friction.
2. Reduced inspection time.
3. Ever-present oil film insuring freedom of rotation throughout long life.
4. Exceptionally pure bearing materials.
5. High factor of safety.
6. Close tolerances through high quality.
7. Strong hydraulic cushion formed by tiny pores filled with liquid lubricant.



All LINE-ARC Contactors on EC&M A-c and D-c Starters and Controllers use self-lubricating bearings on main and auxiliary arm bearings.



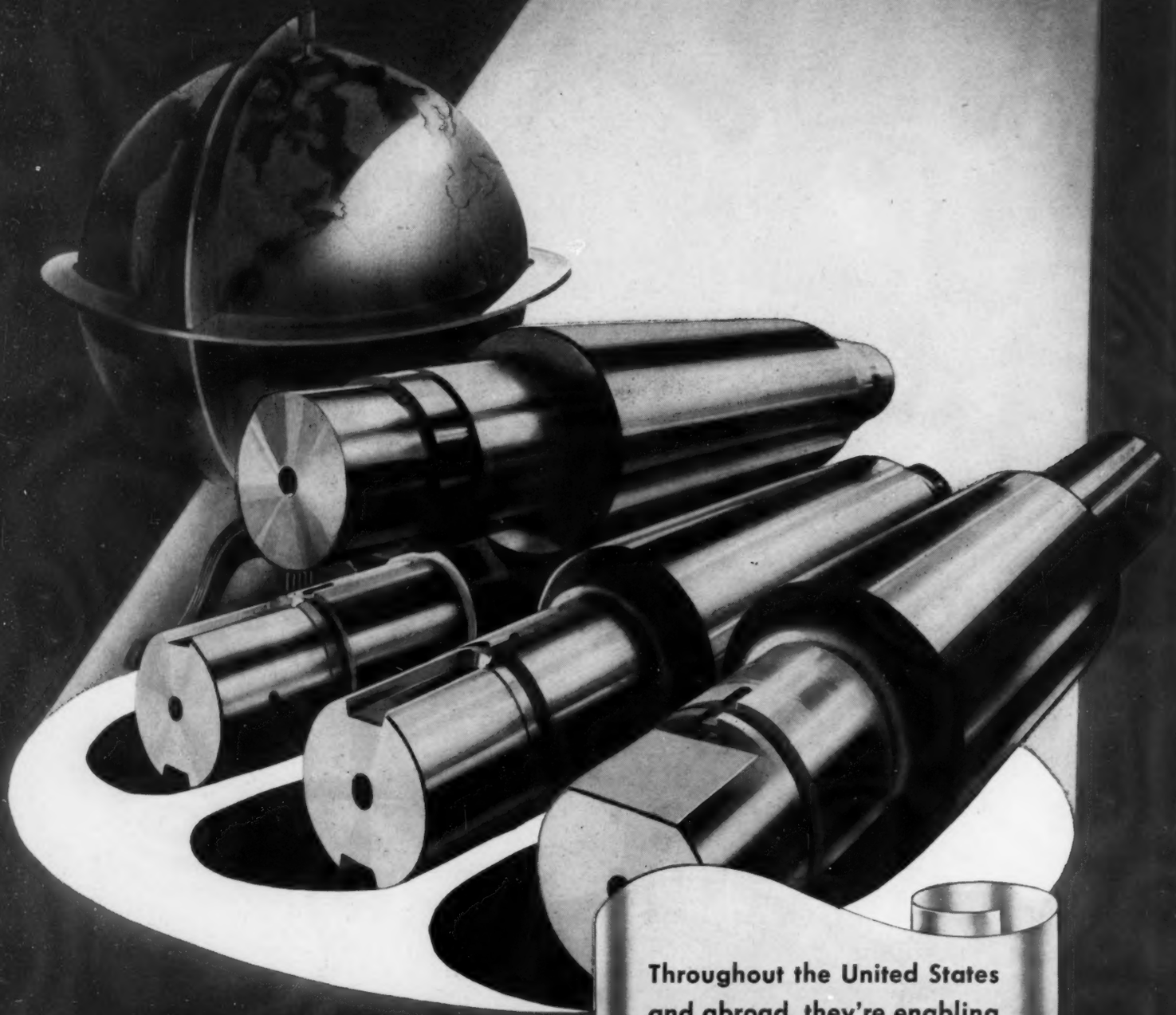
An ever-present oil film on the bearings of all large sizes of WB Brakes permits quick movements due to minimum friction. Bulletin 1004.

Cam Master Switches are equipped throughout with self-lubricating bearings. Bulletin 1190.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 East 79th Street • Cleveland 4, Ohio

LEWIS ROLLS

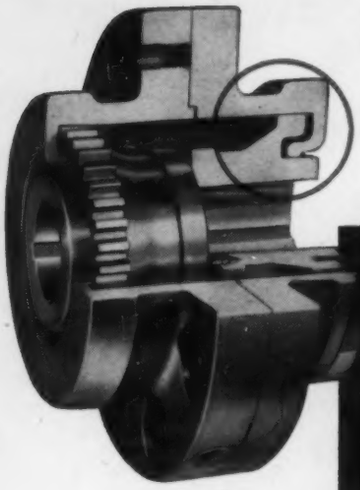


Throughout the United States and abroad, they're enabling mills to meet the demand for still greater tonnage of rolled metals

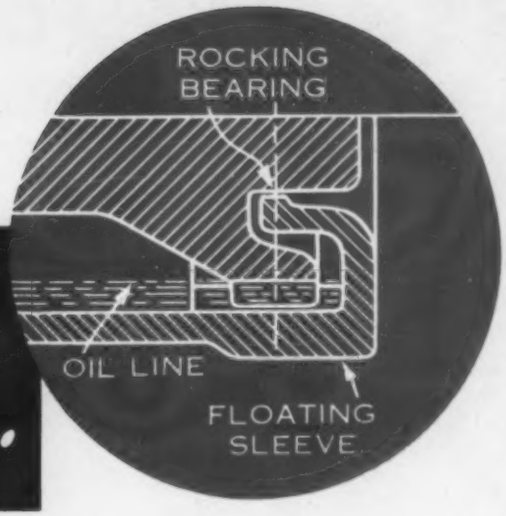
LEWIS FOUNDRY & MACHINE

DIVISION OF BLAW-KNOX COMPANY
PITTSBURGH, PA.

ALSO MANUFACTURERS OF
ROLLING MILL MACHINERY
FOR THE IRON, STEEL AND NON-FERROUS INDUSTRIES



Remember These Points About FAST'S...



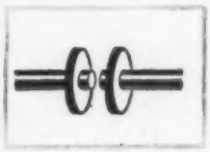
and you can Forget about Coupling Shutdowns

Exclusive Metal-to-Metal Seal Gives You *Extra* Protection

The surest way to stop coupling shutdown worries is to install Fast's Couplings in your plant. For one thing, the *exclusive* "rocking bearing" shown above makes a positive metal-to-metal seal for the load-carrying oil . . . permanently protecting it against wear-producing moisture, dust and grit. No perishable packing rings are used. There's nothing to wear, nothing to fail. The coupling is all-steel throughout—without a single perishable part.

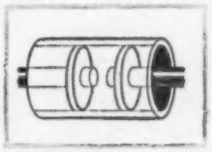
Remember: Fast's self-aligning Couplings are the *original* gear-type couplings. Years of design and manufacturing experience go into every one . . . to give you uninterrupted power transmission . . . to lengthen machine life, lower upkeep costs, minimize shutdown losses.

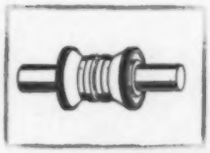
We have a full complete line of couplings for immediate delivery. Get full details on Fast's Couplings now. Write today for your free copy of our complete catalog. Address: Koppers Company, Inc., Fast's Coupling Dept., 217 Scott Street, Baltimore 3, Md.

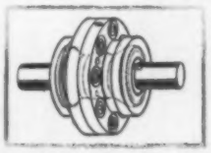


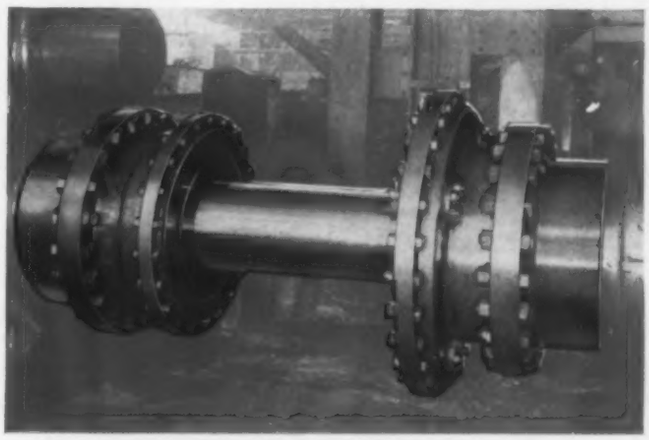
Fast's Couplings Are Simple as A-B-C

See the simple development of Fast's Couplings. A splined hub on each shaft end, a sleeve with internal splines to mesh. Oil in the sleeve carries the load between the splines.





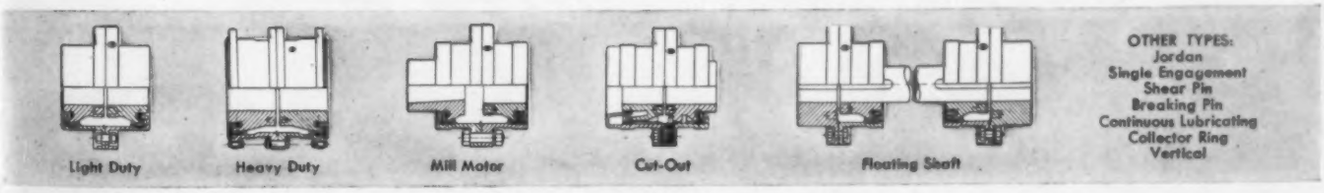




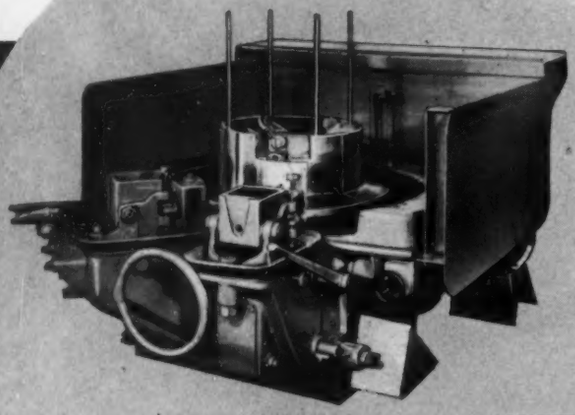
THIS RECENT INSTALLATION utilizes a Fast's Floating Shaft Coupling to compensate for excessive misalignment and a Shear Pin Type Coupling, at the right, to prevent damage in case the driven machine is stopped suddenly.

KOPPERS

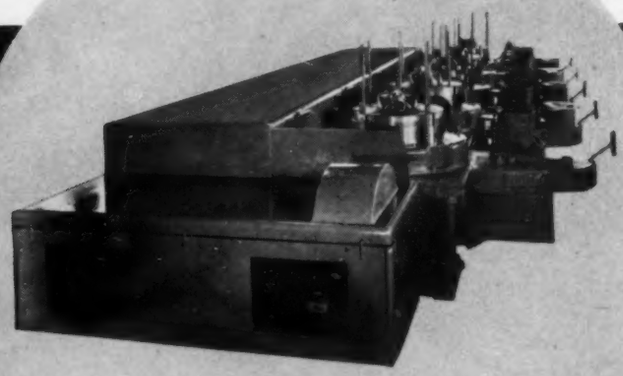
FAST'S *self-aligning* COUPLINGS



PUT YOUR COLD DRAWING MODERNIZATION UPON A *Vaughn* FOUNDATION



VAUGHN MOTOBLOC

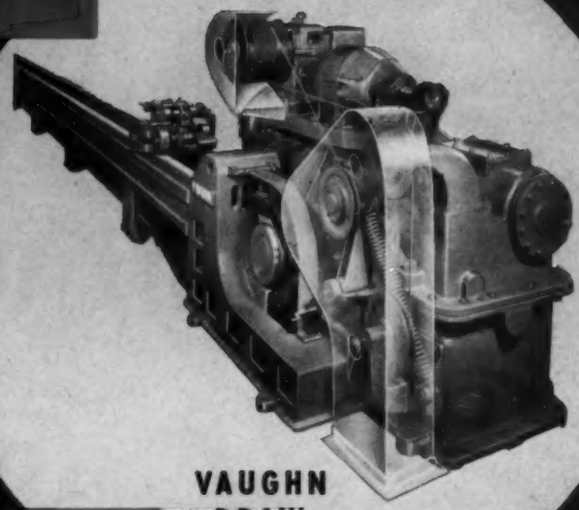


VAUGHN MOTOBLOX

Today's Vaughn Cold Drawing Machinery gives you the advanced performance required by today's competitive production demands . . . and the construction advantages that extend top service over years of profitable operation.

•Let our experience aid your planning program.

VAUGHN CONTINUOUS MACHINES



VAUGHN DRAW BENCHES

VAUGHN MACHINERY

PROFITABLY USED BY LEADING PRODUCERS SINCE 1860

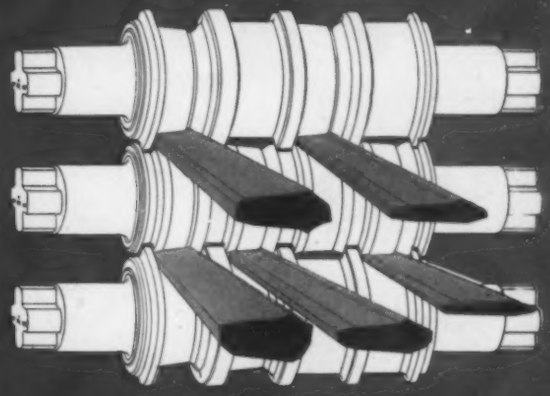
THE VAUGHN MACHINERY COMPANY

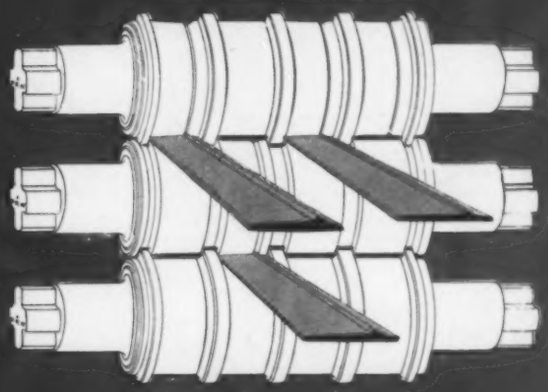
CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

ROLLING TECHNIQUE . . .

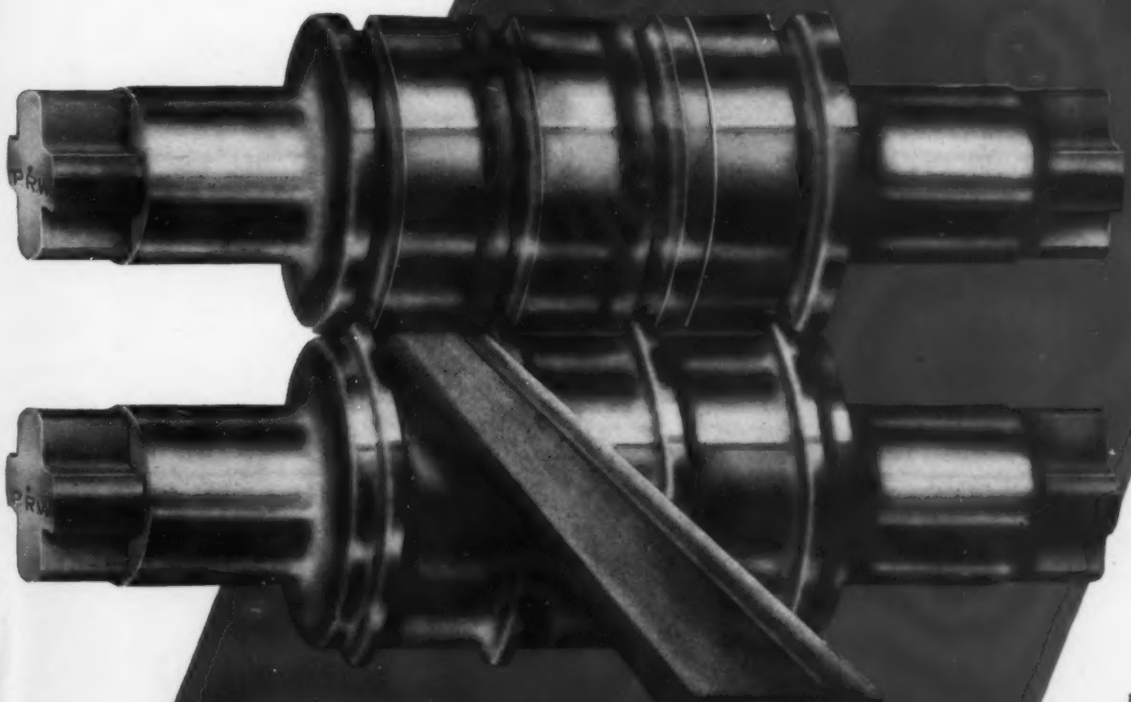
Tie Plate





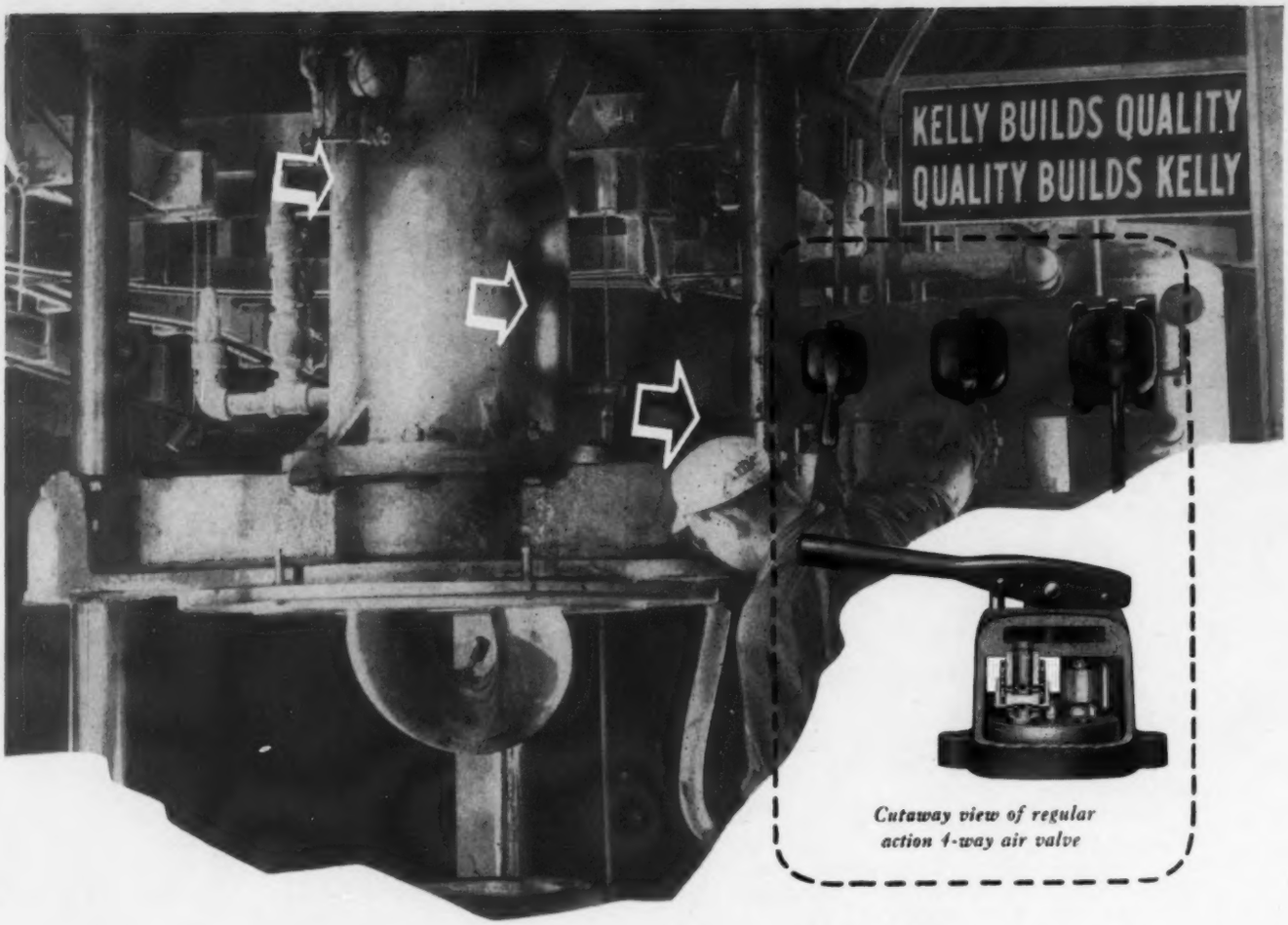
A small piece of steel between the railroad rail and each cross tie might seem unimportant to the average person, but without it heavy or high speed trains could not operate. Cost of track maintenance without these tie plates would be prohibitive. Proper rolls play a large part in producing high tonnage of quality bar to meet present day rigid specifications.

Pittsburgh Rolls, with over three-quarters of a century of roll-making experience and satisfactory performance behind them, can be relied upon to deliver the production of highest quality for which high speed modern mills are designed, at *less cost cost per ton of steel rolled.*



PITTSBURGH ROLLS
Division of Blaw-Knox Compa
PITTSBURGH, PA.

PITTSBURGH ROLLS



Cutaway view of regular action 4-way air valve

. . . Those Who Recognize Quality Use HUNT

Quick-As-Wink VALVES

Wherever quality of product is important, it's generally a good idea to use quality parts in one's production equipment. That's why so many nationally known manufacturers—such as the Kelly-Springfield Tire Company—rely on HUNT Quick-As-Wink valves. Kelly-Springfield makes, among other things, rugged truck tires, and in the tire shaping equipment shown above, HUNT valves provide dependable, precision control.

These are 4-way air valves of the sliding sleeve type, used on normal service air of 80 to 100 pounds, and temperatures below 150° F. This Kelly-Springfield installation is just one of the many applications of HUNT 4-way air valves.

If your plant or production equipment calls for a hand, foot, solenoid, or diaphragm operated valve, let HUNT supply the safe, positive control you want. C. B. Hunt & Son, Inc. makes both hydraulic and air control valves in a wide variety of sizes and types normally required in the operation of hydraulic and pneumatic equipment. Write or call today for complete information or for a copy of HUNT Bulletin 107A.

C. B. HUNT & SON, INC., SALEM, OHIO

Quick-As-Wink
HUNT CONTROL VALVES

● *Built by JONES & LAUGHLIN STEEL CORP.*

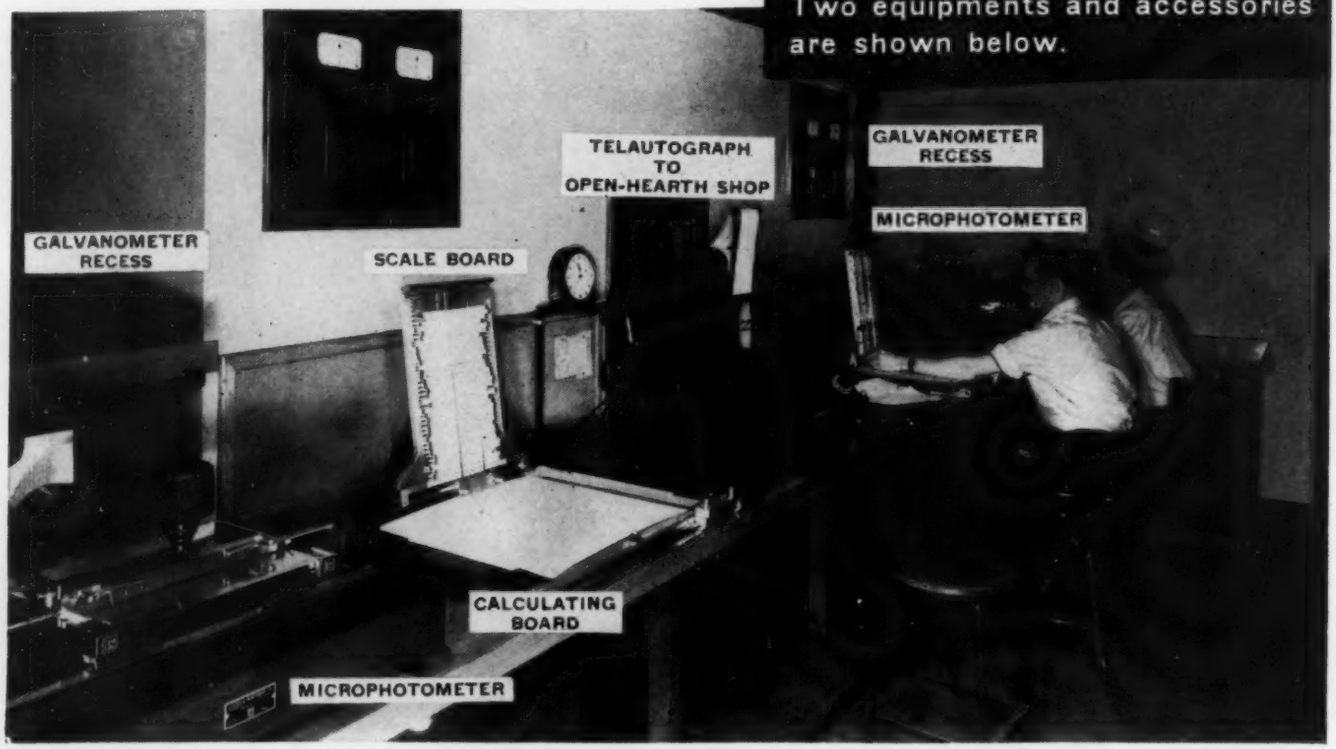
220 SKF BEARINGS!
4,000 MILES OF WIRE PER DAY!

More than 4,000 miles of 0.041-in. wire are wound in 24 hours at Jones & Laughlin's Wire Rope Division, Muncy, Pa., as a result of redesigned mechanical equipment and the use of electronics. And on vital rotating parts of this equipment, 220 SKF Bearings assure smooth, continuous running at high speeds with a minimum of effort. SKF Bearings are produced with extreme care under rigidly controlled conditions to the highest degree of accuracy associated with modern machines and instruments. By manufacturing the greatest variety of ball and roller bearings, SKF can give *you* expert help in selecting the right bearing for the right place. 6274

SKF INDUSTRIES, INC.
PHILADELPHIA 32, PA.

STEEL ANALYSES
Speeded by Vincent-Sawyer MICROPHOTOMETER

Close-up of Vincent-Sawyer Microphotometer and Galvanometer. Two equipments and accessories are shown below.



When the two Vincent-Sawyer Microphotometers shown above became parts of the metallurgical equipment in a certain steel mill, analyses of open-hearth steel began to reach the first helper 15 minutes after samples left the open-hearth shop.

Such speed, never before attainable, is a big help in bringing melts to specified analysis; makes it easier to meet rigid "specs"; is cutting the time per heat.

The operation is quickly explained. Samples from electric furnaces and open-hearths are sped by pneumatic tube to the laboratory, where exposures (spark or arc as required) are made, developed and sent to the microphotometer room. There an operator measures densities of preselected spectrum lines with the microphotometer. Another operator translates density ratios into percentages of elements. Foreman examines analysis and Telautographs it to the shop.

The L&N Vincent-Sawyer Microphotometer has the following advantages in addition to speed:

1. Intended especially for fast, routine analysis.

2. Spectrum plates are positioned quickly and precisely; scanned sharply and accurately. Indicator has no amplifier, hence no pickup.

For technical details, ask for Reprint E-90(1). Leeds & Northrup Co., 4942 Stenton Ave., Phila. 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

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Jrl Ad E-90-0661(1a)

Q: Which brush gives the Right Coefficient of Friction?
Coefficient of Friction
Abrasive or Polishing Action
A: See Speer!

MORE ANSWERS in this book. Get it!

This catalog, *SPEER CARBON PRODUCTS*, gives detailed information on brush characteristics, includes Speer Brush Data Sheets. It answers your questions on brush selection, helps you find the right brush for your motors or generators!

A brush with the *right coefficient of friction* is a major factor in avoiding sparking, excessive wear, energy loss, burning, overheating, and other brush troubles. Many complicating factors, difficult to define, enter into the selection of a brush with this important characteristic properly matched to operating conditions of each commutating or slip ring machine.

Let Speer help you select the brush with the right coefficient of friction to meet your particular requirements. In fact, the Speer brush recommended for your use will combine *all* the right characteristics for your specific operating conditions. That's why Speer brushes bring satisfaction wherever they're installed.

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Left Prefabricated wooden forms in 5-ft. lengths ready for erection on base slab of Refractory Concrete.

Right Refractory Concrete flues for open-hearth furnace. Walls, arches and manholes cast in place without joints.

Time Saved... Cost Cut... Construction Simplified...

Building Open-Hearth Flues with Adaptable Refractory Concrete

An open-hearth furnace had to be rebuilt for war production. Building time was limited. So engineers redesigned the flues, and specified Refractory Concrete made with LUMNITE and crushed firebrick. This new method saved time, cut cost, and simplified construction.

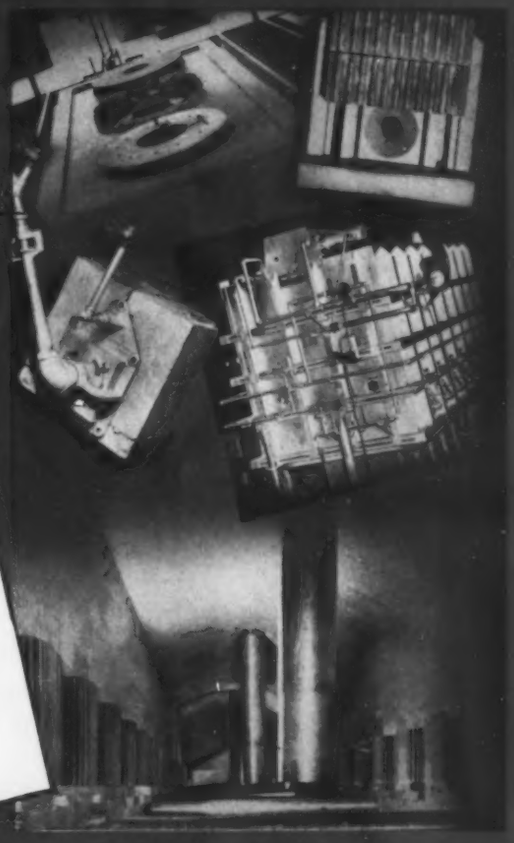
Refractory Concrete was especially suitable for building flues with continuously changing sections, radii and spans. There was no fitting and cutting of small units... special shapes were not required. It was found as easy to place concrete in the tapered and curved arches as in a straight sidewall.

Final cost of the Refractory Concrete job was about 50 per cent of that estimated for other type flues. The aggregate was prepared in the mill from old fireclay brick. And LUMNITE cement produced high-strength Refractory Concrete in 24 hours, so there was no delay in the successive concreting operations.

Results were entirely satisfactory. As a consequence, Refractory Concrete has been used for building flues of two other open-hearths at this large Pennsylvania steel mill.

Send for the complete story of these installations. Write to LUMNITE DIVISION, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York 17, N. Y.

HEAT TREATING PROBLEMS?



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If your heat treating equipment isn't meeting your production requirements—in speed, capacity, economy, efficiency or quality—consult F.E.I. Your problem will be thoroughly analyzed, from original design through manufacture and installation to operation—the complete job. For dependable, efficient heat treating equipment, you can depend on Furnace Engineers. Our equipment can utilize with equal efficiency natural gas, coke oven gas, butane, oil refinery gas, clean producer gas, Galusha gas, clean blast furnace gas.

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- For Wire, Bar and Tube Mills: Galvanizing, Patenting and Normalizing Furnaces.
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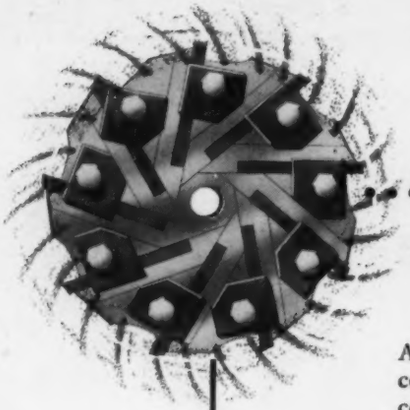


. . . These teeth slashed $892,528 from billet-conditioning costs!

A Leading Mid-Western Steel Plant using Bonnot Billeteers recently set-up a cost study program to determine the economy of machine billet chipping as compared to other conditioning methods. The study covered 24,965 tons of billets ranging in size from 4" x 4" to 8" x 8". To eliminate all possible variables billets were conditioned by each method through a range of different heats.

Results of this study showed that Billeteer conditioning cost 56% less than hand chipping, 39% less than hand scarfing. These percentages were then used to determine the savings effected during the prior five year period. For purposes of comparison, Billeteer conditioning cost was set at $1.00 per ton with basic rates for other methods being adjusted to conform with actual differentials revealed by tests. Here are the figures:

BILLETEER	714,022	$1.00	$ 714,022	———
HAND SCARFING	714,022	1.63	1,163,856	$449,834
HAND CHIPPING	714,022	2.25	1,606,550	892,528

Billeteer savings over hand scarfing were almost half a million dollars.
Billeteer savings over hand chipping were not far from one million dollars.

Here's HOW The Billeteer Cuts Conditioning Costs

INCREASES MAN-HOUR PRODUCTION . . . a single Billeteer operator can do the work of 10 hand chippers . . . and do it better.

INCREASES SCRAP RECOVERY . . . every Billeteer chip "comes clean"—classified as to analysis—ready for the charging box.

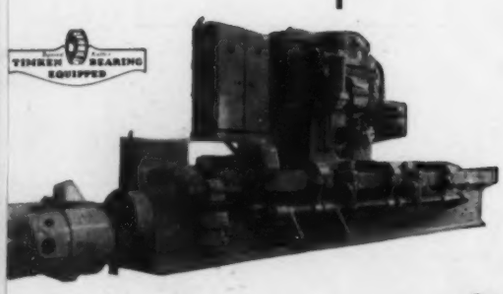
SPEEDS CRITICAL DELIVERIES . . . by permitting reclamation of bad billets and even bad heats, it facilitates maintnance of delivery schedules — reduces pick-up items at the melt shop.

INCREASES BILLET SALVAGE . . . Billeteer's low operating cost permits recovery of badly seamed billets unprofitable to salvage by other methods.

REDUCES BILLET INVENTORY . . . since otherwise "unsalvageable" billets can be saved, inventory of billets and ingots can be reduced to a minimum.

INCREASES WORKER EFFICIENCY . . . the Billeteer's 45 ton weight takes the punishment of chipping — saves workers from jitters, fatigue, and illness.

And . . . these savings were accomplished with only one disabling accident in 490,000 Billeteer man-hours. Learn how much the Billeteer can save YOU. . . . *Write for full information.*



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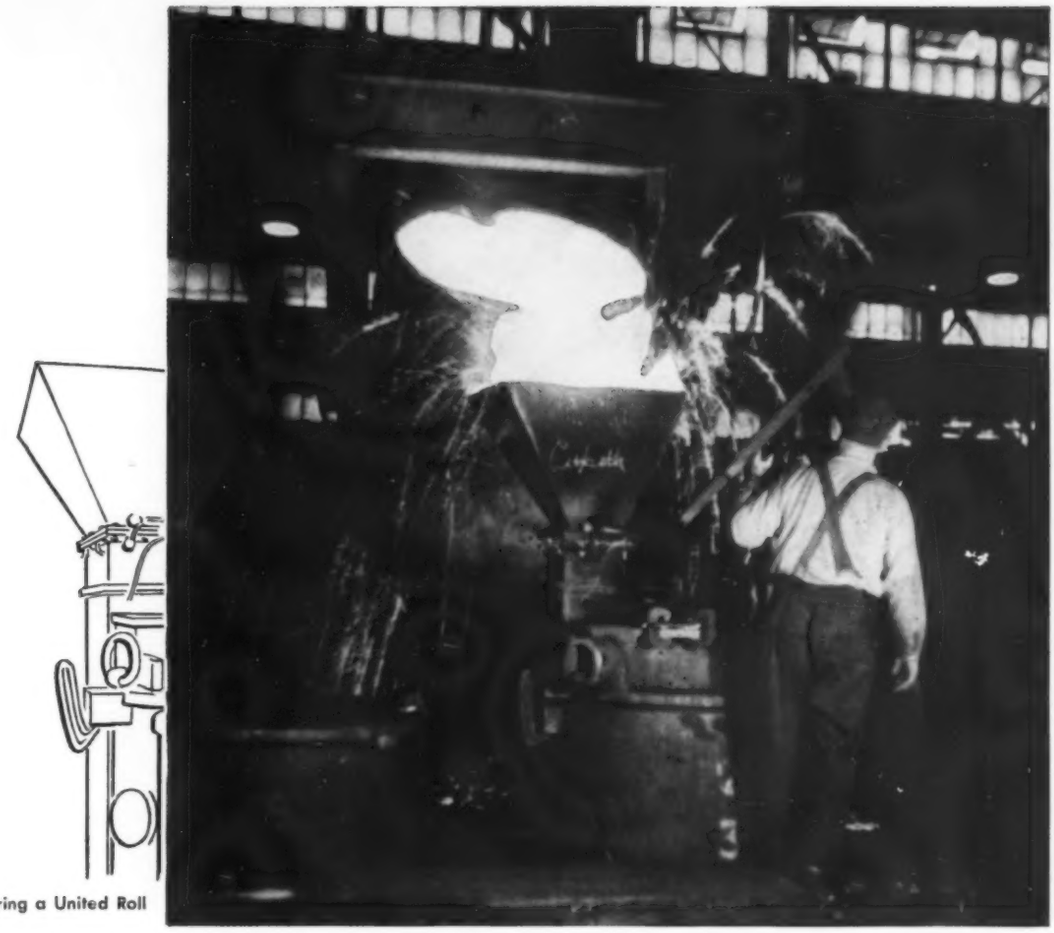

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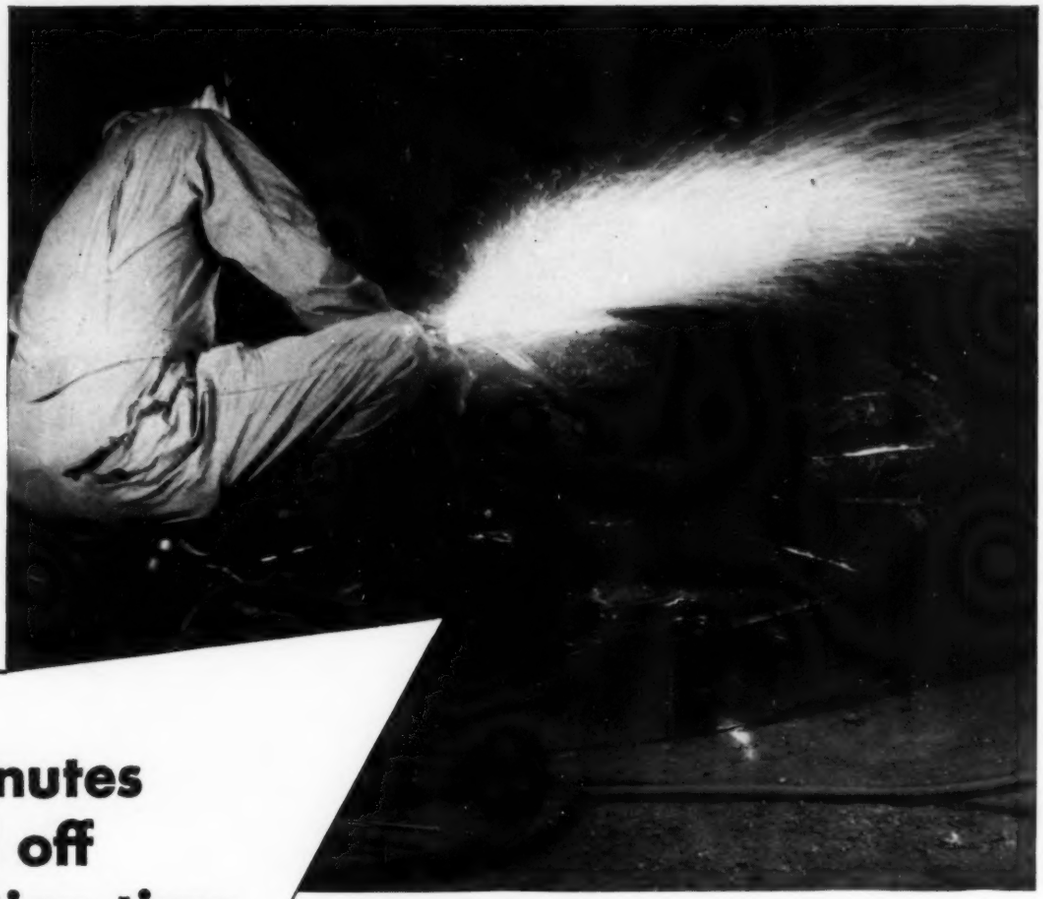

150 minutes slashed off production time

Formerly, the Pittsburgh Steel Foundry Co. removed sixty-pound riser pads from cast steel locomotive drive wheels by grinding . . . a slow, laborious procedure that took 3 hours per wheel.

Now, using Airco's modern flame scarfing technique, similar riser pads are removed in thirty minutes; thus 150 minutes of grinding time per wheel are eliminated, castings are ready for finish machining.

This is another example of the manner in which Airco modern oxyacetylene and electric arc methods are helping progressive foundry operators slash production time and costs.

For details of other applications of these two versatile production tools in foundry operations, write for a copy of "New and Improved Oxyacetylene Methods for Steel Foundries". Address Dept. IS-6786, Air Reduction, 60 East 42nd St., New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas. Represented Internationally by Airco Export Corporation.

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. . . use I-T-E MT Circuit Breakers

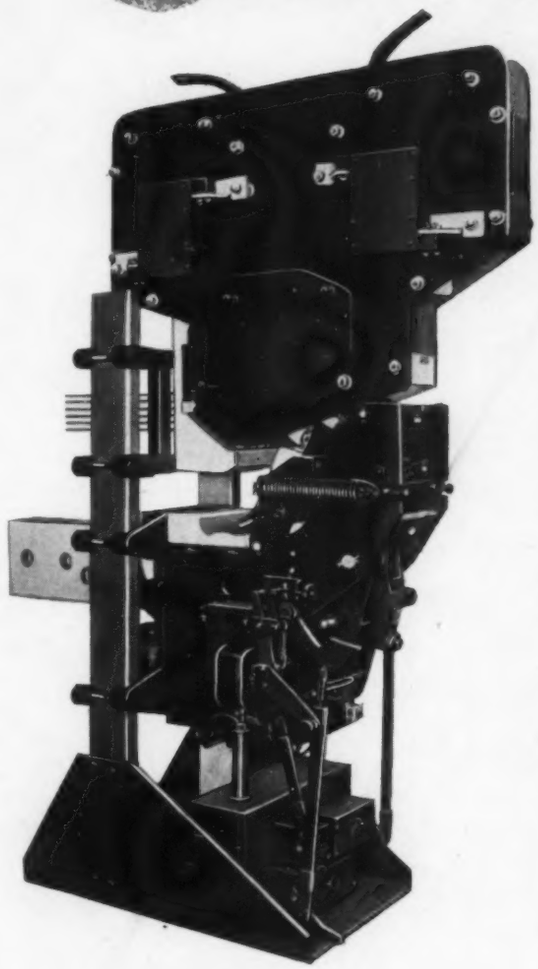
When lost minutes due to an electrical fault may mean dollars in maintenance and lost production, the I-T-E MT Type Circuit Breaker is your safeguard. It protects your costly equipment from damage, and instantly confines trouble to the area where it occurs.

Unnecessary tripping is prevented through the action of the "Rate of Rise" overcurrent trip which differentiates between a useful high-value load and a direct short circuit. Interruption is fast and occurs before high short circuit values are reached.

Type MT Circuit Breakers are designed for semi-high speed interruptions in circuits where both the load and potential short circuit currents are high. The main contacts are solid blocks of copper with ample cross section to carry rated currents safely. Silver alloy inserts insure contact surfaces free from heating and oxidation.

Secondary contacts prevent main contacts from arcing—the main arc takes place between a third set of contacts with brazed silver-tungsten block inlays which provide high resistance to arcing. The magnetic field from a blowout coil forces the arc into an arc quencher where it is extinguished.

There is an I-T-E Switchgear Specialist in your neighborhood who will be glad to give you complete details. Use him—at no obligation. For Catalog 2201 on MT Circuit Breakers write to I-T-E Circuit Breaker Company, 19th and Hamilton Streets, Philadelphia 30, Pa.



The rated interrupting capacity of the Type MT Circuit Breaker is 150,000 amperes in capacities 2,000 and 4,000, and 250,000 amperes in capacities 6,000 and above.

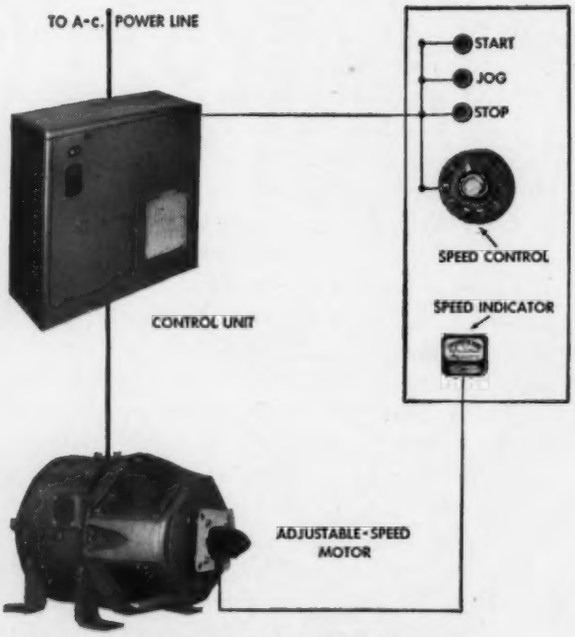
I-T-E *The center of Switchgear Progress*

SWITCHGEAR • UNIT SUBSTATIONS • BUS STRUCTURES • AUTOMATIC RECLOSING CIRCUIT BREAKERS HIGH SPEED CIRCUIT BREAKERS

RELIANCE V★S DRIVE

Greater PRODUCTION with ADJUSTABLE-SPEEDS

...from A-c. Circuits



Conveniently-packaged, space-saving V★S Drives are available from 1 to 200 hp.

Actually, Reliance V★S Drive is an *electric transmission.* At the touch of a button your machine can be started or stopped. Turn the knob of a rheostat and it can be accelerated or decelerated smoothly—over an infinite range of stepless speed changes. And with this *All-electric, Adjustable-speed Drive operating from A-c. Circuits,* control can be either automatic or manual . . . at the machine or from remote stations. The net result of V★S control is greater efficiency, faster production, lower costs—as already proved in every industry. That's why it will pay you to write today for Bulletin 311.

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RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"

GIANT SIZE DISHED HEADS

Accurately Spun at Low Cost

ON BIRDSBORO FLANGE SPINNING MACHINES

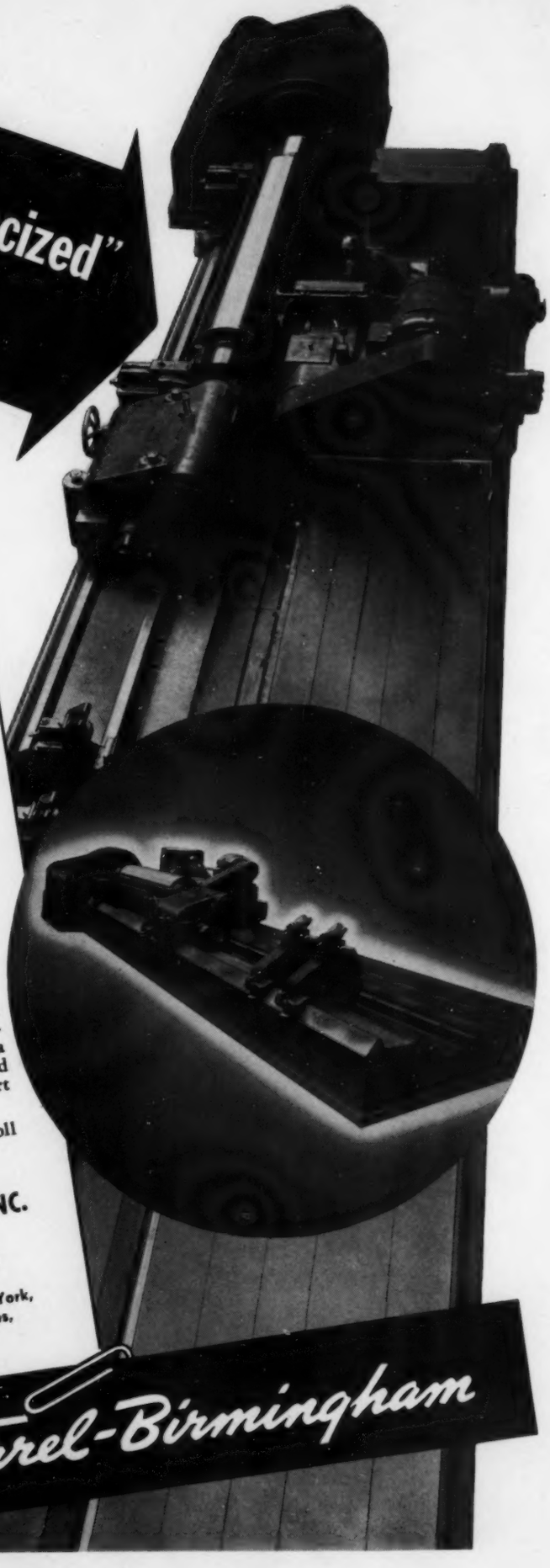
When you have an "out-size" dishing job, look to Birdsboro Flange Spinning Machines to give you close tolerances and low cost as well as speedy operation. The machine shown is flexible in control and capacity, has a clearance of 17' between columns and forms flanged and dished heads from plates ¾" to 4" thick.

Designing and building such special purpose machinery is an everyday function here at Birdsboro. Our engineering staff is ready at all times to cooperate in applying their specialized knowledge to give you a practical solution to your heavy equipment problems.

BIRDSBORO

STEEL MILL EQUIPMENT

This roll is being "accuracized" on a Farrel 60" Grinder



With the Farrel Type HD, Heavy Duty Roll Grinder it is a simple matter to grind rolls to required accuracy and finish. The more important design features that contribute to *automatic precision* include:

AUTOMATIC CROWNING AND CONCAVING DEVICE—This built-in "brain" automatically produces a mathematically accurate curve for either a crowned or concaved roll, with both halves perfectly symmetrical. The same setting invariably produces exactly the same curvature.

GRINDING WHEEL SPINDLE—Of large diameter for rigidity under working load—made of high grade alloy steel, heat-treated and precision ground—mounted in adjustable bearings, automatically lubricated.

WHEEL SPINDLE AND HEADSTOCK DRIVES—Work and wheel are both driven through multiple V belts. Their smooth, vibrationless transmission of power safeguards precision.

TWO DEAD CENTERS—Dead centers in both headstock and footstock insure concentric rotation of the work, which contributes to precision grinding of journals and bodies.

INVERTED V WAYS—Cast separately from the bed, of a special grade of alloy iron, they are exceptionally resistant to wear, maintaining accuracy for a long life. Automatically pressure-lubricated and covered by flexible metal guards to exclude dirt and grit.

For the complete story of the Type HD Roll Grinder, send for descriptive bulletin.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.

Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, Stonington, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston, Charlotte

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FB-404

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60 MORGAN MERCHANT MILLS

roll out high tonnages, accurately, at low cost

Higher production, greater accuracy, and lower cost per ton is the three-fold objective of every mill we build.

There is no standard Morgan mill. Each is engineered and built to meet specific needs. And we believe each mill is more efficient and better adapted to the circumstances than its predecessor.

Producers the world over have found it profitable to come to Worcester for their rolling mill equipment. If *your* plans call for rolling merchant shapes, we believe it will pay *you* to talk with our engineers.

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RM-12

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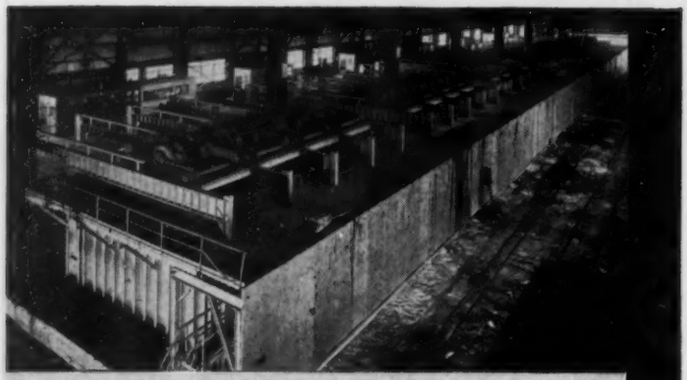
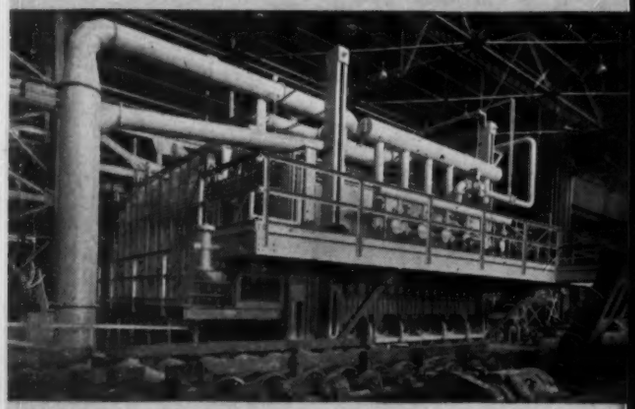
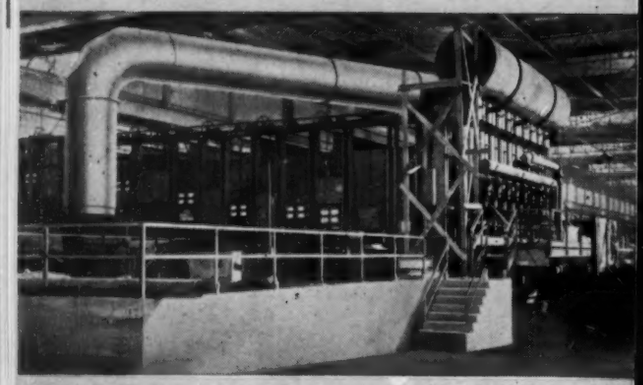


"Surface" one-way fired soaking pits



"Surface" slab heating furnace



"Surface" billet reheating furnace

"Surface" continuous heat treating furnaces for plate

FROM INGOT TO FINISHED PRODUCT

Hundreds of installations, including the modern One-Way Fired Soaking Pits... Slab, Billet and Round Heaters ...Continuous and Batch Normalizers and Annealers — Muffle-type and Radiant Tube Fired, Controlled Atmosphere Furnaces... give outstanding proof of "Surface" acceptance wherever heat is used in the Steel Industry.

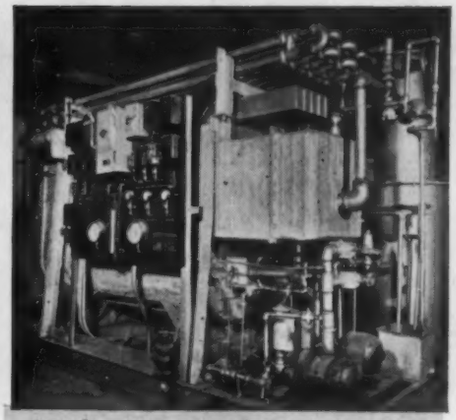
"Surface" collaboration with metallurgists and engineers in the metal producing and working industries, plus the years of constant laboratory research in the scientific application of gases, heat and mechanisms to the many heating problems, have resulted in continuous improvement in equipment to give the desired result. Only a few such installations are shown herewith, representative of "Surface" developments in the industry.

Now, when quality tonnage is paramount, "Surface" is ready with modern processes and methods to meet the world's demands.

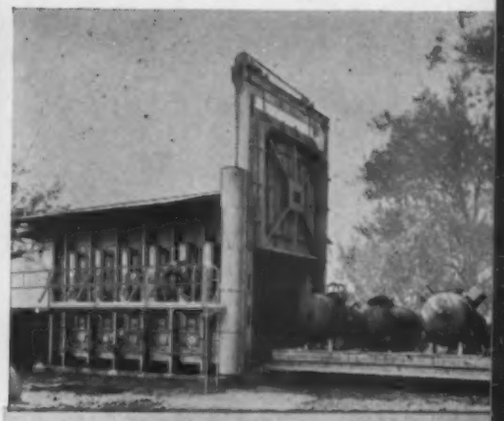
'Surface'

SURFACE COMBUSTION • TOLEDO 1, OHIO

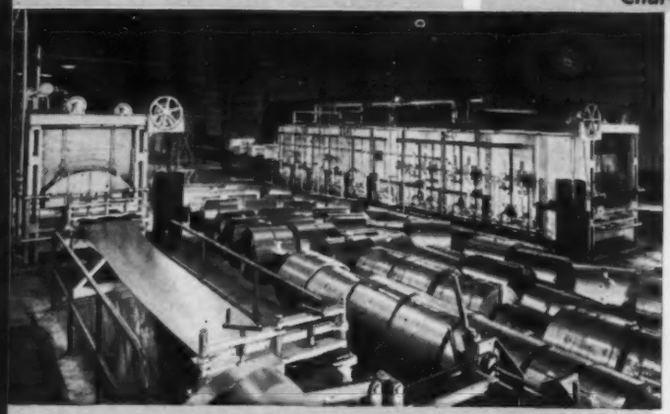
"Surface" rod annealing in pit type convection furnaces



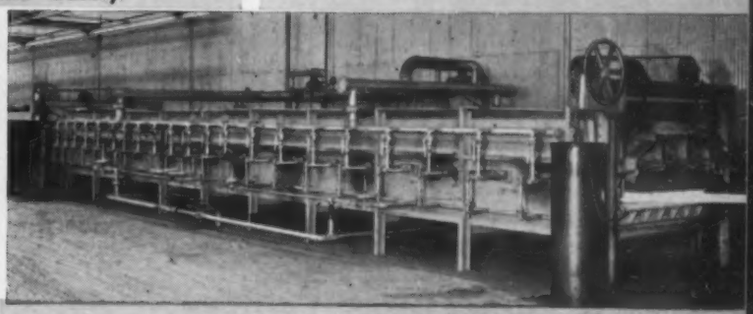
"Surface" prepared gas generating equipment (NX, RX, DX and Char-Mo Gases).



"Surface" stress relief furnace

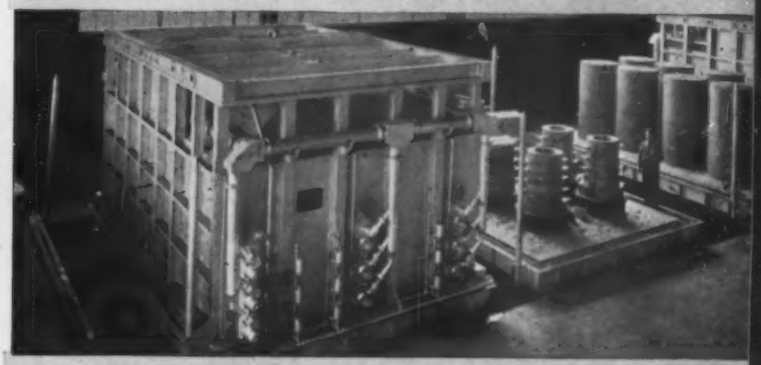


"Surface" continuous controlled atmosphere strip annealing and normalizing furnaces



"Surface" wire patenting furnace

"Surface" high alloy rod and bar atmosphere annealing lift-cover with car-bottom furnace



"Surface" controlled atmosphere coil and sheet annealing covers

"Surface" bright annealing and normalizing furnace for tubing

"Surface" controlled atmosphere wire and rod annealing furnaces

PUT THIS SINGLE STAGE PRESSURE BLOWER ON THE 24-HOUR SHIFT

"Buffalo" Pressure Blowers are delivering up to four pounds per square inch in a single stage — doing it 24 HOURS A DAY with no let-up in efficiency.

The "Buffalo" CC Centrifugal Compressor shown is available in sizes to handle from 4,000 to 75,000 c.f.m. at pressures up to eight inches of mercury. For the lower pressures, a welded steel rotor is furnished — for the high pressures, a one-piece, high tensile, cast aluminum alloy rotor. These rotors are fully tested up to 70,000 feet per minute tip speed in the "Buffalo" Vacuum Test Pit for critical vibration and rotating stresses. Removable side plates on housing are stiffened with ribs to stand pressure of 12 lbs.

If you need high pressure, continuous service blowing, put a "Buffalo" Blower on the job. It will give you more air for your money. Bulletin 3553, yours on request.

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Inside Knowledge on Lubrication Problems
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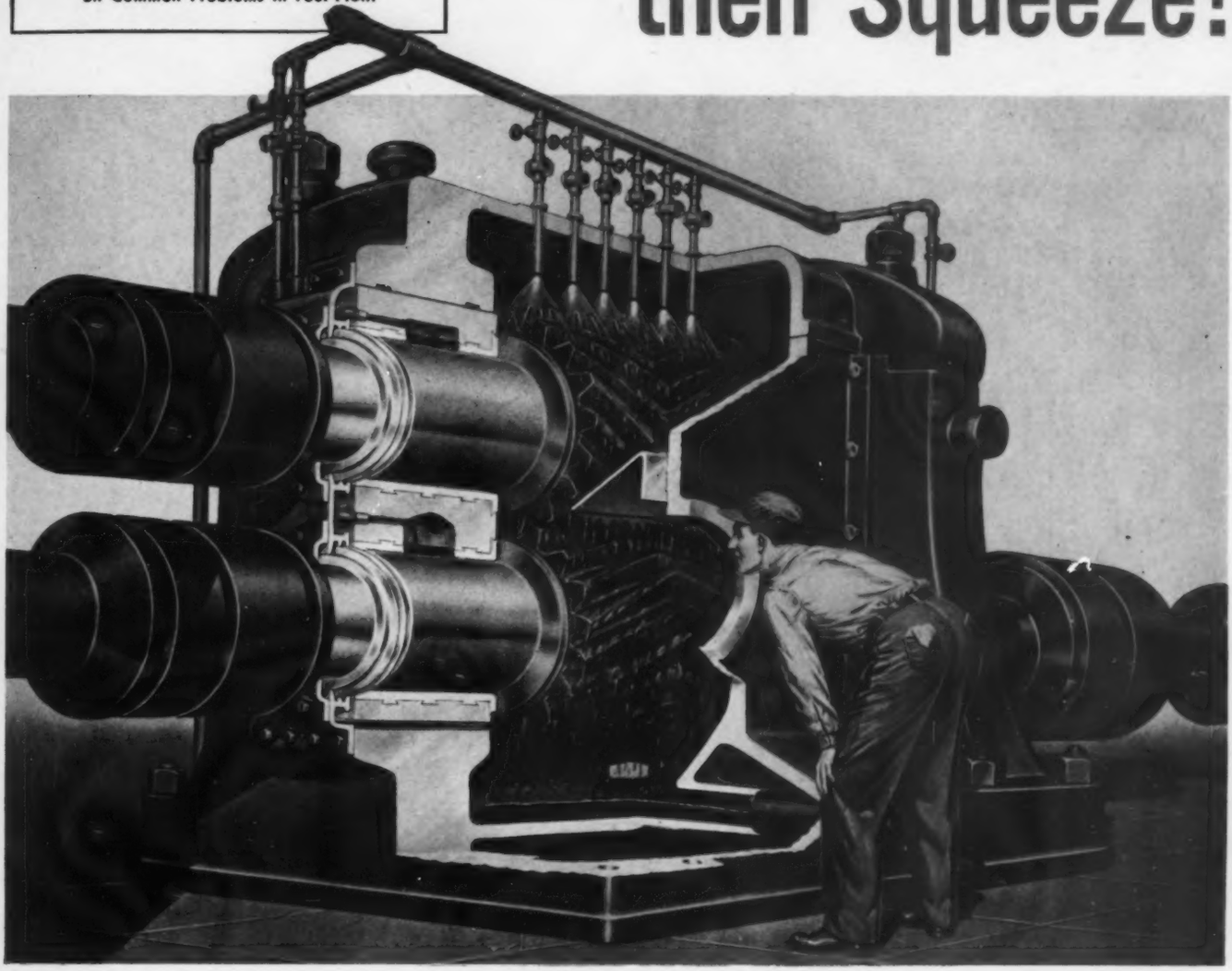
This is One of a Series of Messages on Common Problems in Your Plant

Big Shock—and then Squeeze!



WHEN ingots, billets or slabs smack the work rolls in your mill, the terrific shock of the impact is transmitted instantly to these pinion stand gears.

The follow-through is almost as severe as the shock. As the steel moves on through the work rolls, these gears are subjected to extremely high pressures that run into thousands of pounds per square inch.

This shock-load, high-pressure job calls for a special prescription lubricant that will resist rupture under the constant pounding of shock loads, a tough, tenacious film that will cling to the gear teeth despite the squeezing action of the high pressures.

Gargoyle Compounds have proved to be the solution to this problem in many mills. They not only stand up under the shock loads and heavy pressures, but also resist deterioration in continuous use to assure low oil consumption. Put them in your steel mill pinion stands now for maximum protection.

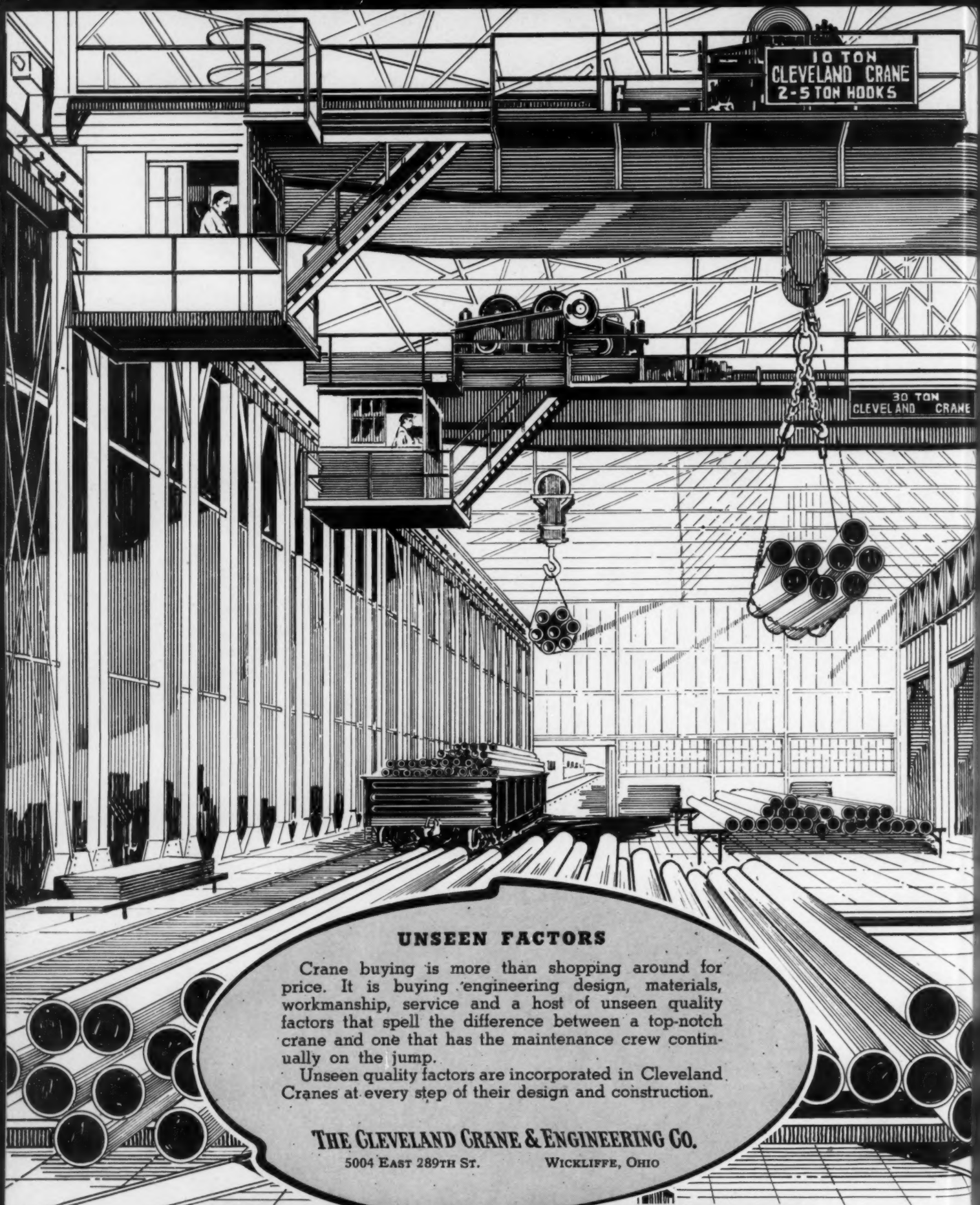
GARGOYLE Lubricants

SOCONY-VACUUM

SOCONY-VACUUM OIL CO., INC.
and Affiliates: Magnolia Petroleum Co., General Petroleum Corporation

Socony-Vacuum Correct Lubrication

FOR EVERY MACHINE . . . EVERY OPERATING CONDITION



UNSEEN FACTORS

Crane buying is more than shopping around for price. It is buying engineering design, materials, workmanship, service and a host of unseen quality factors that spell the difference between a top-notch crane and one that has the maintenance crew continually on the jump.

Unseen quality factors are incorporated in Cleveland Cranes at every step of their design and construction.

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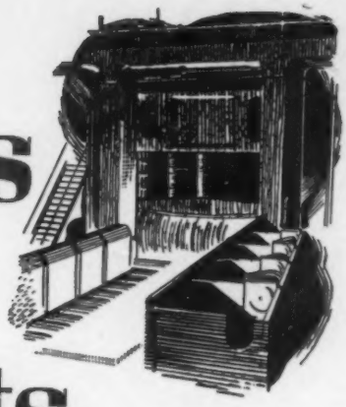
CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts



ACCORDING to the American Iron and Steel Institute, each dollar which the steel industry received from sales in 1946 was spent as follows: 41 cents for payrolls, 40 cents for materials and supplies, 5 cents for taxes, 4½ cents for selling and administrative costs, 3½ cents for depletion and depreciation, 3½ cents for dividends to stock and bond holders, and 2½ cents left in the business as reserve for future needs.

▲

ADDITIONAL figures from the Institute show that 51 steel companies, accounting for 91 per cent of the total ingot capacity, earned $264,419,213 in 1946, third best of the past 10 years but 19 per cent lower than in 1941. This represents 6.3 per cent return on the companies' investment. Gross income of these companies totaled $4,811,213,000, a drop of 18.7 per cent from 1945.

▲

PRESIDENT TRUMAN has repeatedly urged industry and business to cut prices, even in the face of repeated wage increases, many of which were government-encouraged. Maybe our economics are bad, but darned if we can reconcile the thinking that industry can get along on less income with the idea (as indicated by veto of the proposed tax cuts) that government can't get along on reduced income. And along the same line, we can't see where lower prices are being encouraged by the government's artificial support of prices of food and agricultural products, where our most violent price increases occurred.

▲

TO HELP combat fuel gas shortages occasioned by cold weather peaks, Allegheny Ludlum Steel Corporation is installing, at their plant in Brackenridge, Pennsylvania, twenty cylindrical tanks, each of 20,000 gallons capacity, in which liquid propane will be stored. Total maximum storage will be 360,000 gallons, which is roughly equivalent to 13½ million cubic feet of propane gas of about 2400 Btu per cubic foot, equivalent to about 32,000,000 cubic feet of natural gas. The tanks are installed above ground.

▲

AN EDITORIAL recently carried by McGraw-Hill publications offers a lot of food for thought. Under the heading "Your Chances of Getting Ahead," the editorial presents figures showing the changes that have come about in establishing a fixed measure of independence. The objective set is to save a stake over 25 years that will yield an income from investment equal to $3000 a year in 1929 dollars. It is assumed that $4000 per year, in 1929 dollars, is spent on living expenses. Results show that this could be done under 1929 conditions on an annual salary of $5267, whereas $13,221 per year is now necessary. In 1914, the same thing could be accomplished on a salary of $3075 per year.

Changes in three factors — income taxes, living costs, and interest rates — have caused this. These factors have swung as follows:

	Typical income tax		Cost of	Interest rate on
	$5000.00 income	$10,000.00 income	living index	bonds, per cent
1914	$ 10.00	$ 60.00	71.8	5
1929	3.00	40.00	122.5	5
1947	589.00	1862.00	155.0	2½

We're sorry if these figures blast your dreams of being able to relax someday in your hammock with your favorite pipe and possibly a julep, and with a comfortable feeling of financial competence, but that's the situation at present. A reduction of government spending, coupled with a reasonable reduction in living costs and a slight increase in interest rates would do much to restore the incentive to work for the future.

▲

HOWEVER, those of us who have occasion to travel might not be averse to postponing retirement if the railroads convert rapidly to equipment similar to the "Train of Tomorrow," the General Motors brainchild now touring the country. This train has practically every comfort for its passengers. With such equipment, travel would become a real pleasure — "tomorrow" can't come too soon.

▲

FINISHED steel shipments hit a new peacetime record in April, when 5,445,993 net tons were shipped. During that month, sheet and strip shipments set a new record at 1,566,932 net tons, composed of 630,700 net tons of hot rolled sheet, 458,933 tons of cold rolled sheet, 134,701 tons of galvanized sheet, 49,961 tons of electrical and enameling sheet, 151,323 tons of hot rolled strip, and 141,314 tons of cold rolled strip.

▲

DIVIDENDS, a house organ of Ketchum, MacLeod and Grove, Inc., hands out some excellent advice on how to start a depression which we paraphrase lightly as follows:

If you are selling goods, moan about the high prices you are charging.

Don't attempt to sell on the basis of the product's superiorities over earlier and cheaper models.

Ignore the fact that prices are never going back to 1939 levels.

Ignore the fact that our national income is now running at the rate of 175 billion dollars, whereas it was 70 billion in 1939.

Forget that prices are high because labor is completely employed at rates far above those of 7 or 8 years ago.

If you hear a prediction of trouble, misquote it and magnify it out of all proportion.

Never pass along any good news.

If you still have an easy time selling, give the worst possible service.

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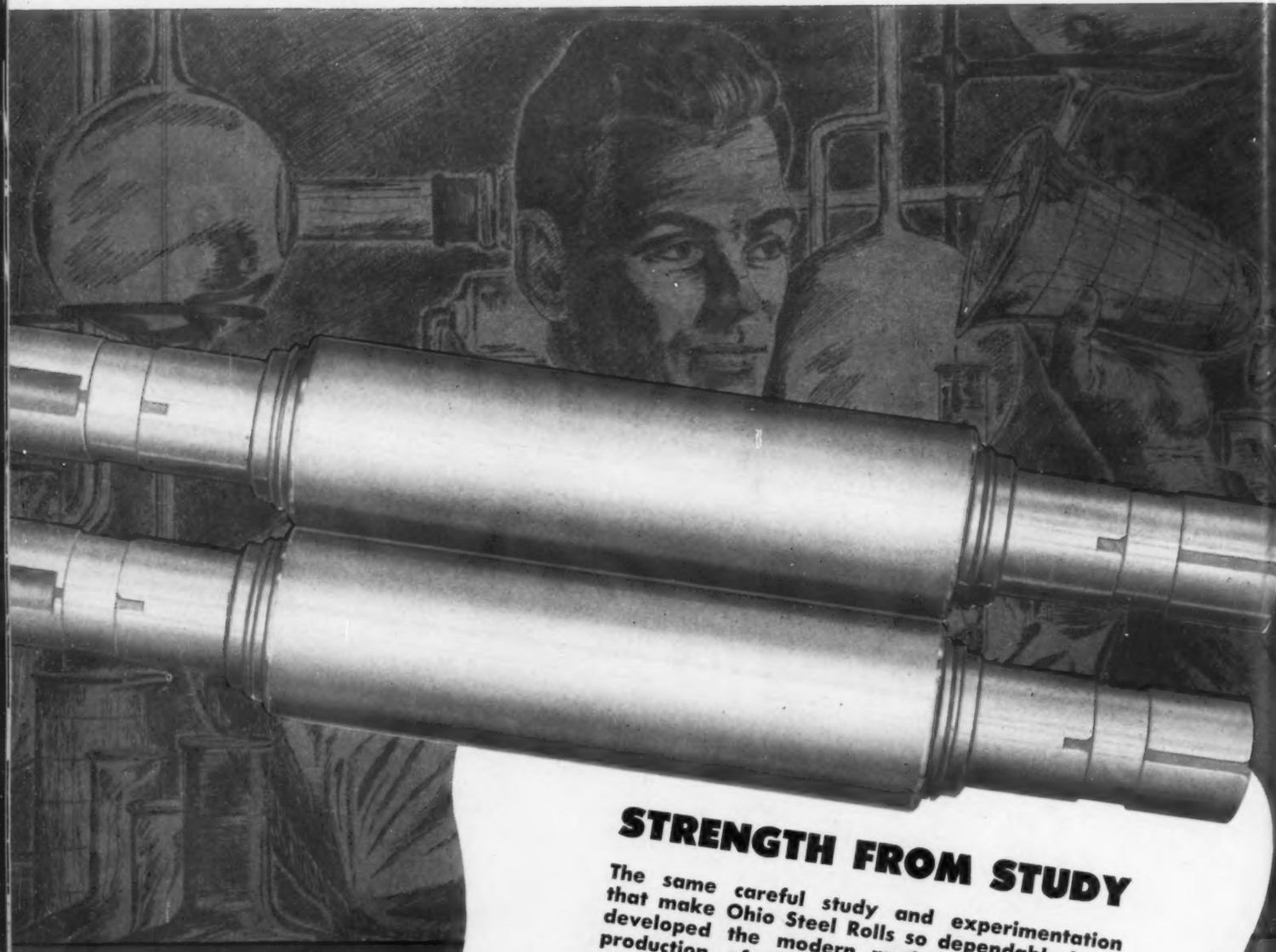

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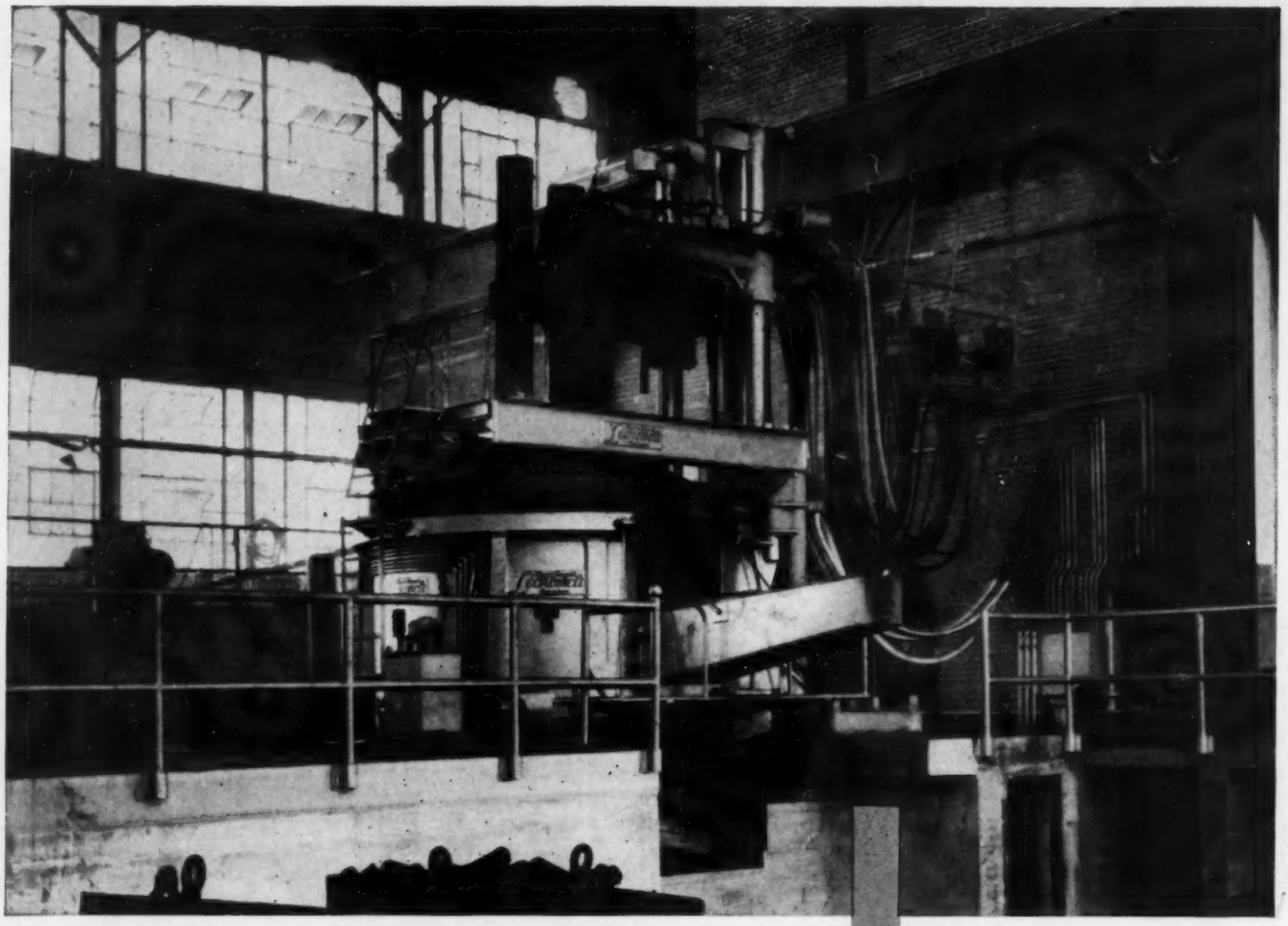

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REFRACTORY ECONOMY IN STEEL MILL FURNACES

. . . . the steel mill brick mason can offset adverse effects of changed combustion practices, either by alteration of furnace design or by the use of higher quality refractories . . . .

By EDWIN N. HOWER
General Masonry Foreman
Homestead Works
Carnegie-Illinois Steel Corporation
Munhall, Pennsylvania

▲ REFRACTORIES and combustion in steel mill furnaces are in a continual contest, with combustion always on the offense. The changing refractory service conditions, resulting from radically altered combustion practice during the past fifteen years or so, have made it extremely difficult for the men in charge of furnace construction to keep furnace life and costs within bounds.

There are a great many destructive influences working on refractories in an industrial furnace, but the destructive influences which have most often been caused by changing combustion practice during the past few years have resulted in softening the refractories under load, fluxing, and spalling, all primarily as a result of increased mean temperature of the refractories.

Figure 1 shows a forging furnace immediately prior to a relining, in which the results of these destructive influences are clearly evident. The side walls, which were constructed with first quality firebrick, show softening under load with eventual collapse of sections, spalling as a result of vitrification under high temperature, and (not visible in the picture) rather severe fluxing of the lower part. The silica brick roof shows that, although no softening took place, the intermittent operation of the furnace, with attendant temperature changes, caused excessive spalling. The back wall of the furnace, which was constructed with a super refractory, gave excellent service and was used as a guide in selecting materials for the next rebuild of the furnace.

The steel mill brick mason has two tools at hand with which to meet those changes in combustion practice which adversely affect refractory life. They are alteration of furnace design and the use of higher quality refractories. To meet a given condition, one or the other or both are frequently employed.

One of the most widespread advances in combustion practice in recent years has been the change from a negative furnace atmospheric pressure to zero, or, more generally, positive pressure in the work chamber of most furnaces. As shown in Figure 2, the mean temperature of a furnace wall proper is increased by hot furnace gases escaping through the cracks and crevices when the furnace pressure is positive. On the other hand, the mean temperature of the wall is decreased by the cooling effect of outside air drawn in through the openings when the furnace pressure is negative. The increase in temperature may be even greater in some cases such as that of brick in a door arch which is in contact on both side and bottom with hot gases at furnace operating temperature instead of being constantly washed by an incoming stream of cool air.

The results of such a change are shown in Figure 3. This is a view looking in the door of a batch type billet heating furnace. The construction of this furnace was such that the front skewback for the sprung roof rested on the piers and door arches. A change from negative to positive furnace pressure raised the temperature of these arch brick above their softening point under load, and subsidence accompanied by vitrification and spalling occurred. The failure of the door arch resulted in the roof failure shown although there was no failure of the roof brick. In meeting this condition, a design change was found necessary and excellent results have been obtained by installing a suspended roof.

Sometimes a given change in combustion practice may produce entirely unexpected results and cause conditions which are extremely difficult to define. A combination of destructive influences presents a difficult refractory problem, that is if a shrinkage condition is corrected, will the spalling be eliminated too, and vice versa. In such a case, however, if one has a fair idea as to why one material does not work, there is usually a reasonably good basis for selecting something that will. But if an unknown factor is present causing furnace

Presented before AISE Annual Convention, Cleveland, Ohio, October 3, 1946

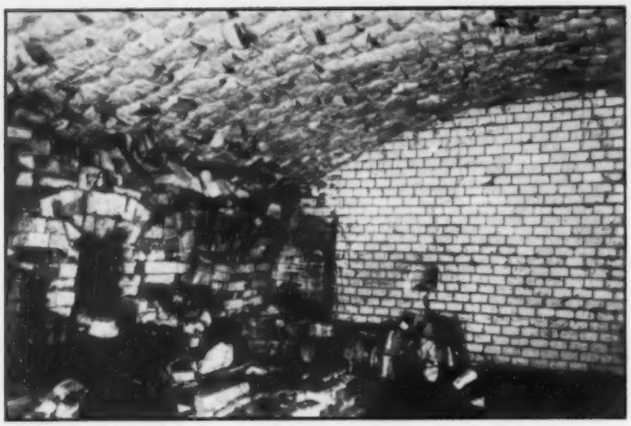


Figure 1 — Increased combustion temperature accelerated the spalling and softening of the refractories in this furnace.

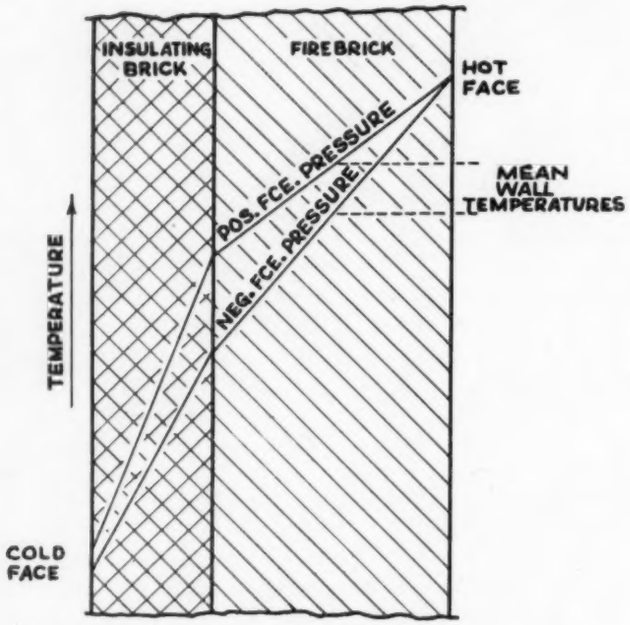
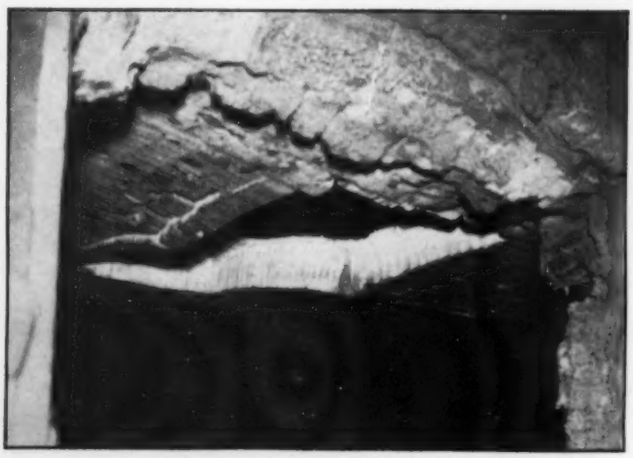


Figure 2 — Positive furnace pressure increases the wall temperature of the furnace.

▲

Figure 3 — This roof failure was due to the collapse of the supporting door arch.



failure, the refractories mason is likely to be at a loss for an answer.

A rather unusual example of this occurred several years ago in a slab heating furnace. The fuel was changed from gas to oil, which caused no particular concern as the furnace had been giving good service with a suspended super-duty clay roof. This roof was thought to be perfectly capable of withstanding oil firing at the same temperatures as existed with gas. Shortly after the oil firing started, however, the roof commenced to vitrify, spall and drip quite badly. In a short time it was gone. It was felt that it was a pretty old roof to begin with and many thought that perhaps it was worse than was realized at the time, so a new roof was installed. The new roof, however, started in right where the old roof left off. First the brick makers were called to account, but they firmly maintained there was no change in their products. Analyses and tests of several shipments proved this to be the case. To check further, samples from the roof were analyzed. This disclosed an alkali pick-up of over two per cent, which indicated the cause of the failure, but there was no clue as to the source of the alkali. After working with the problem for several months, during which time the oil was analyzed and no alkali found, the source was unexpectedly discovered to be the atomizing steam. The alkali was present in a large quantity because an automatic water treating plant had broken down, with repair parts unavailable for some time. The attendant was manually adding soda ash to the water and making sure that he had enough. Whenever the steam lines were shut off at the burners, the excess alkali would settle in the lines, and when the lines were opened this alkali would be sprayed out and blanket the roof. An improvement in the water treatment plus the installation of high burn super quality fire clay refractories eliminated the trouble and in fact gave better results than had ever been experienced before.

Most open hearth operators are familiar with the use of drop sections in the roof adjacent to the skewbacks as shown in Figure 4. This practice and the use of basic brick in the same location have come gradually as a result of improved combustion practice, mainly because of the elimination of air infiltration at these points. Lower fuel costs and shorter time of heat, however, are advantages which more than offset increased refractory costs. The increasing use of premium priced heavy duty refractories in all types of furnaces is evidence not only of improvements in the science of producing refractories, but also of the heavier demands being placed on these refractories by improved combustion practices.

The inter-relationship of a good many factors in addition to fuel and refractory costs is shown in the following studies which were made covering a six-year period in the operation of some batch type slab heating furnaces. It should be noted that these curves do not depict actual costs, but do show the relationship between various costs and the changes in cost. The cost changes illustrated cover a period of experimentation and final installation of pressure controls on these furnaces.

During this period extensive insulation was adopted and the furnace pressure in the heating chamber was gradually changed from a varying negative value to a

positive pressure of approximately 0.05 inches of water. Here the condition depicted in Figure 2 was reached. The change from negative to positive pressure plus more effective sealing and some insulation served to increase the mean temperature of the furnace brickwork anywhere from a hundred to three hundred degrees. In most furnaces operating at temperatures in excess of 2200 F, an increase in temperature of this magnitude means that the safe limits of the refractories in use will be exceeded and premature failures are to be expected. Unfortunately, these changes usually take place slowly or without any warning and most of us are prone to attribute a premature failure to accident or operating abuse. It usually takes several repeat jobs to establish the condition. Once the conditions are known, it is generally not difficult to select a material which will give adequate services at a reasonable cost.

An examination of the curves in Figure 5 shows the type of results that are pleasant to obtain. These curves covering a six-year period in the operation of small (about 8 ft × 32 ft hearth) batch type slab reheating furnaces, show an irregular decrease in fuel cost with a corresponding increase in furnace repair and rebuild costs. This is the cost not only of refractories but also of labor and miscellaneous furnace materials such as steel, castings, etc. As would be expected, the repair costs increased quite rapidly at first and then reached a leveling off point in the last couple of years. The pleasant part is that the total cost was reduced about three cents a ton, as the fuel savings exceeded the extra repair costs. In such a case, the justification of the altered firing practice is obvious from the repair and fuel costs alone.

Figure 6 shows cost curves for a similar but somewhat larger group of furnaces. In these furnaces the changes in costs were of greater magnitude than for the previous group but followed a similar pattern. Here, however, the increase in furnace repair costs was not overbalanced by the reduction in fuel costs and the net tangible result is an increase in total cost. There are, however, several factors of importance in an over-all analysis of the economics of the operation of the entire mill which are difficult to evaluate, but which may go a long way towards offsetting the increased costs shown in such a simple analysis as this.

Reduced heating time is an important factor. It is almost impossible to measure accurately its value in dollars and cents but its value in increasing the capacity of existing equipment, and in permitting more flexible scheduling is evident. Reduced scale loss is another important factor. In addition to the actual tonnage of steel saved from loss as scale, there may exist an indeterminate but important saving by reduction of surface defects on the product. This decrease in the formation of scale during heating takes place because a change from negative to positive furnace atmospheric pressure is generally accompanied by a change from a highly oxidizing atmosphere to one which is more nearly neutral or reducing. These cost savings are real but impractical of exact measurement by ordinary means.

Another curve has been included in Figure 6. That is the average furnace life in this mill measured from one major repair to the next. The value shown for any one year represents the average life of all furnaces taken off for repair during that year.

As a matter of fact, furnace life, whether measured in months, heats, or tons, is the day-to-day yardstick by which most operators measure the performance of their furnaces. Dollar and cents cost sheets, while of primary importance, are usually examined in the light of previously observed operating results, and the cost sheet tells "how much" and not "what" has happened.

At the beginning of the period surveyed, and for several years prior to that, the life was about two years.

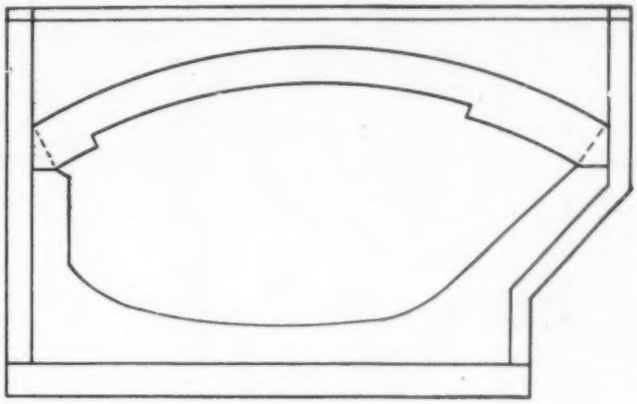


Figure 4 — Drop sections in the front and rear of the roof decrease time of heat and fuel costs.

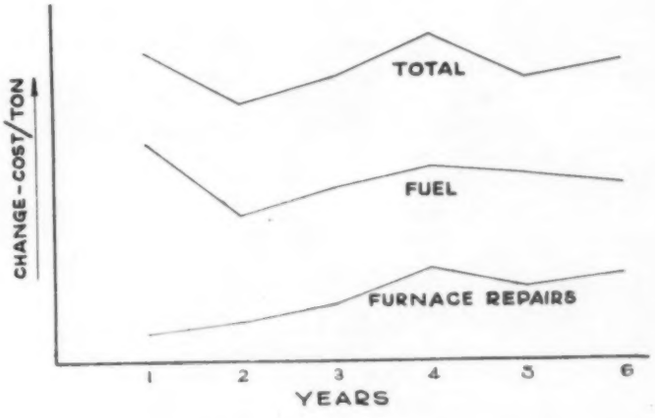


Figure 5 — In the chart are shown the changes in furnace and fuel costs during a period of change in combustion practice. Fuel savings were greater than increased repair costs.

During the next two and a half years the life steadily declined to a low of about eleven months and then, as the use of higher quality refractories began to take effect, gradually rose to a figure of about 18 months at the end of the six-year period. After that time it continued to increase and three or four years later, without major charges in design but continued improvements in the application of refractories, reached its former time of approximately two years. The cost remained up, however, due to the use of more costly materials.

The problem of maintaining furnace linings under

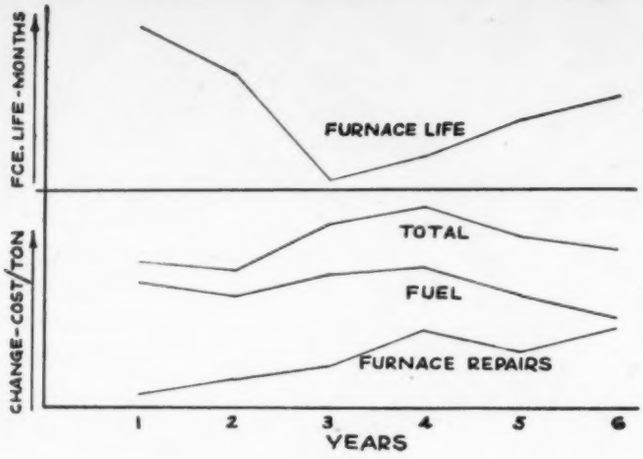


Figure 6 — In this change in combustion practice, fuel savings were insufficient to counteract increased furnace repair costs.

changing combustion practices is not static but continues to change and to present new and difficult questions. Who, for example, can appraise accurately all the values connected with a heating practice which so reduces furnace time that a former sixteen turn schedule can now be rolled in fifteen turns, but at the cost of more expensive refractory materials and greatly increased repair and rebuild time? Such a change does not take place from one week to the next, but it has taken place in many mills over a period of years as improvements have been made in the science of combustion and furnace operation.

To realize fully the benefits to be obtained requires the constant cooperation of the operator, the design engineer, the combustion engineer, and the furnace brick mason, with each understanding the problems of the others and subordinating his own problems to those of maximum quantity and quality of tonnage at the lowest over-all cost.

DISCUSSION

PRESENTED BY

W. TRINKS, Associated Engineers, Pittsburgh, Pennsylvania

EDWIN N. HOWER, General Masonry Foreman, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania

J. G. HIMES, Carnegie-Illinois Steel Corporation, Youngstown, Ohio

E. C. HITE, Combustion Engineer, The Timken Roller Bearing Company, Canton, Ohio

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A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

G. R. McDERMOTT, Vice President, Surface Combustion Corporation, Toledo, Ohio

B. B. BARGMAN, Superintendent, Fuel, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania

W. Trinks: I have a question about open hearth roofs. In Europe, they have used basic roofs. As I understand it, open hearth reactions proceed much more rapidly if we can maintain a higher temperature in the open hearth furnace. That has been shown lately by the use of oxygen during the melting period. We cannot use oxygen during the refining period because it would melt down the roofs. What progress has been made with basic roofs in the open hearth furnace?

I know that at one time, I think it was in 1923, a steel company in Pittsburgh installed a silicon carbide roof. I think the roof fell in after two weeks of operation. So there seems to have been a good example of combustion versus refractories.

At one time a friend of mine wanted to fire an open hearth furnace through the roof, straight down, and the idea looked so good to me that I endorsed it. A few small furnaces were installed, and a larger one near St. Louis was so equipped. The theory was wonderful. What happened was that firing straight down at high velocity stirred up so much iron oxide dust that it came up against the roof and produced what they call fayalite. I am not a good metallurgist, but I believe that is really nothing else but ferrosilica. The roof was washed down in a great hurry.

I think the same thing would happen if what has recently been suggested were applied; I refer to firing from the rear of the furnace toward the doors, or between the doors over the bath. Such a firing arrangement would also stir up a large amount of iron oxide and throw it right against the opposite wall, causing a great deal of difficulty.

So while the open hearth as now built is nothing but a compromise, it is a pretty good compromise at that.

Edwin N. Hower: The use of basic brick for open hearth furnaces, from what I have seen and heard about recent developments, is still in the experimental stage, but the experiments are daily becoming more promising.

There have been frequent reports in the last several years of basic installations, and I think we are getting closer every day to all-basic furnaces, as a successful operating furnace. To date some good results have been obtained on the port ends of the furnaces, but to the best of my knowledge no one has successfully and economically operated a full-basic roof on a furnace, but they are getting closer.

J. G. Himes: As I understand it, there are two problems limiting the general acceptance of a basic open hearth roof. First, the basic roofs are considerably more expensive to construct. Secondly, a basic roof does not have the thermal shock properties of a silica roof over the operating temperature range of an open hearth furnace. Is that true?

Edwin N. Hower: It is definitely more costly. A factor that has increased that cost differential is that so far the most successful basic installations have been suspended, and that again adds a differential on top of the straight cost of basic brick material as compared with silica which is in ratio of about 5 or 6 to 1. Thermal

shock is one of the experimental and controversial problems. Various companies are trying to solve that with various proportions of chrome and magnesite materials and burned and unburned brick, with steel-jacketed brick, and so forth, but that is still experimental and controversial. So far the thermal shock has been very detrimental and generally lead to failure.

J. G. Himes: What sort of increases in maximum furnace operating temperatures might we expect with this basic roof if we work out the other two problems? In other words, the brick is the limiting factor to fuel men, if we could go safely a few hundred degrees higher, we could expedite getting those heats out, and that is the thing we are after.

Edwin N. Hower: That is quite true. It is possible that ultimate increased furnace temperature with successful basic roof could be 150-200 degrees more, at least for a short period of time.

E. C. Hite: I might add one thought in answer to Mr. Trinks' question regarding the use of silica brick. Probably most of you are aware, but maybe a few are not, you cannot satisfactorily maintain silica brick in an open hearth roof unless they are surrounded by an oxidizing atmosphere. Most of the time you do have oxygen bathing the silica brick which keeps the iron oxidized to the higher form, as Fe_2O_3, which does not flux silica brick as much as FeO does. I rather suspect that the cause of failure of the silica brick in the down-fired open hearth was partially attributable to the fact that FeO was formed instead of Fe_2O_3.

H. S. Hall: In the opening statement in the paper, the author said that fuel was always on the offensive. I think he should have gone on to the next statement and said the combustion engineer is always on the defensive.

In the first place, we are on the defensive, because the furnaces won't heat. We do all we can to get steel out a little faster, and then we are again on the defensive, because we burn the furnaces down.

E. C. Hite: Mr. Hower brings out the point that quite often the refractories and combustion men are at odds with one another because their objectives seem to conflict so often. This probably is quite often true, but certainly in many cases changes which increase combustion efficiency also increase refractories efficiency for, after all, the fundamental reason for burning fuel is to heat or melt steel rather than destroy refractories. It should be remembered, however, that fuel costs per ton usually run from four to ten times as much as refractory costs. As a result, when a contemplated change indicates there will be an increase in efficiency of combustion, although there may be a corresponding percentage decrease in refractories efficiency, the overall consideration generally indicates that the change should be made.

Mr. Hower also touches on the so-called "intangibles," which are always affected by changes in combustion or refractories practice. Quite often such items as improvement in quality of work, both from a metallurgical or physical point of view, improved production rates, or change in the amount of scale formation are more important controlling factors than either the fuel or refractories costs.

A. J. Fisher: We at Bethlehem are now redesigning our fuel and refractory cost sheets so that we will have parallel records of both fuel and refractory costs. In our plants, ceramic and fuel engineering are combined in a single department. By coordinating the fuel and refractory engineering programs, we believe we can maintain the most economical balance between fuel and refractory costs.

G. R. McDermott: I was interested in the remarks of the speaker on the effect of alkali on refractories. We also get alkali in certain grades of bunker C oil which causes the same trouble on refractories as experienced with boiler feed water and thereby steam used for oil atomization.

B. B. Bargman: We started out using fuel oil, due to war conditions, in one shop, and I believe in the beginning we obtained our oil from about 13 or 14 different suppliers. The fuel men argued with the purchasing department, and insisted on the constant supply of a bunker C fuel oil, and they ultimately reduced the number of sources down to four, and we now have it down to three suppliers, one supplier only giving us probably five or ten per cent, and it has made considerable difference.

In support of his statement on it being the soda ash in the steam, I happen to know that we were having considerable trouble also throughout other parts and mechanisms in our steam system, that the soda ash was building up, and we were not only getting it from the brick people, we were getting it from the valve people and quite a few others. We did ultimately eliminate the trouble.

I can recall back more than ten or twelve years ago, when we first tried this furnace pressure proposition, and the ideal furnace pressure, was the one which would reduce fuel, improve furnace practice, but the brick people objected strenuously, and we had to recognize that there was some optimum point.

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▲

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building

Pittsburgh 22, Pennsylvania

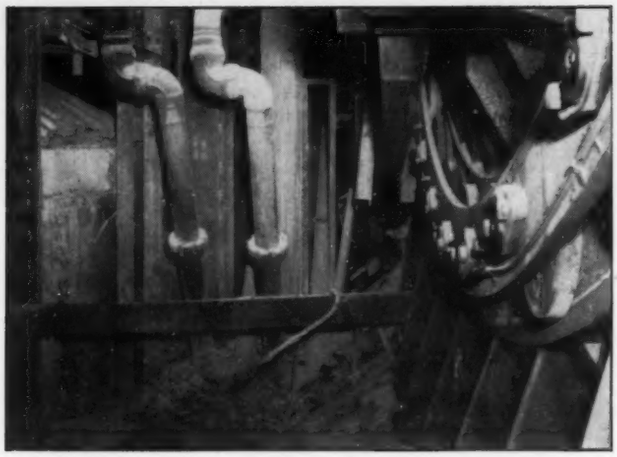
FLEXIBLE STEEL MILL *Pipe Lines*

By R. C. WILSON, Piping Superintendent,
Kaiser Steel Company
Fontana, California

▲ IN BUILDING the Kaiser Steel plant at Fontana, we had one advantage, which would be appreciated by any man who has been in the steel producing business for long. That advantage was that we started from scratch, and had no problem of having to maintain production while undergoing a program of obsolescence and replacement. With this in mind, every effort was made to equip every part of the mill, from blast furnace to shipping platforms, with facilities which would not require frequent replacement due to rapid wear or deterioration.

The problem of developing a system of flexible lines was given serious consideration because it is well known that flexible hose of fabric composition is a constant source of trouble, since it may become hung up, or tangled and broken, or torn by moving equipment. Due to high temperatures to which it is exposed, it dries out and catches fire from sparks. We wanted to avoid these conditions to as great a degree as possible.

Rigid pipe lines would have been ideal, but did not provide for swing or rotation. The next problem, then, was to find a swivel joint which combined low torque or easy turning with an effective pack-off which would not require frequent adjustment or tightening to keep it from leaking. It was also necessary to find a swivel joint of all-steel construction which would withstand high temperatures as well as high pressure. After investigating and testing several different varieties, we adopted a swivel joint which turned easily on two rows of ball bearings, with a self-adjusting pack-off consisting of a well designed packing ring. It has nothing to require tightening or adjustment, and the packing element being maintained under pre-regulated pressure.



Flexible lines with swivel joints are used on the tilting furnace.

Some uses of this swivel joint in making up flexible lines for typical installations throughout the plant is illustrated by the accompanying photographs. Swivel joints are used on hydraulic leveler lines under pressures from 3750 to 5000 psi; on descaling equipment in all mills; on roll cooling lines in the blooming mill, handling water at 70 to 95 F under 55 lb pressure; for cooling rolls and bearings and for lubricating lines in the rolling mill; on fuel lines to the hot metal mixer, handling oil and steam at 450 F at a pressure of 195 psi; on the ladle dryer and open hearth furnaces; and on by-product loading lines.

In some instances, the lines are moving almost constantly; while in others, movement is only occasional. In every case, however, it is essential that the swivel joints withstand high temperatures and heavy overloading without danger of breakage. On lines handling fuels, lubricating oils, and other combustible materials, breakage could cause serious fires or injuries to personnel due to burns. In the case of cooling and descaling lines, breakage would result in expensive shutdowns for repairs.

Dangling loops of loose hose are eliminated, making it impossible for the hose to get hung up in the machinery or to get in the way of plant operators. Since the swivels actually operate on double rows of ball-bearings, they maintain perfect alignment. At the same time, they absorb any vibration in the line itself. This is important since it prevents pipe breakage due to crystallization.

Installations such as those shown here have been in use since the Fontana plant first started and are proving entirely satisfactory in every way. As new equipment is added, it is fitted with steel pipe lines and the proper combination of swivel joints. As producers of steel, perhaps we are prejudiced in favor of steel wherever it can be used, and in this case, we have found it to be entirely in our favor.

The all-steel flexible lines, which are used for roll cooling in the 36 in. blooming mill, are in almost constant motion.

Application and Maintenance of Hydraulic Equipment

. . . . hydraulic power, perhaps the oldest form of power used by man, has, in the last twenty years, undergone marked development . . . . speeds have been increased, higher pressures are used, and greater capacities are available . . . .

By C. E. POWELL
Manager, Machinery Division
R. D. Wood Company
Philadelphia, Pennsylvania

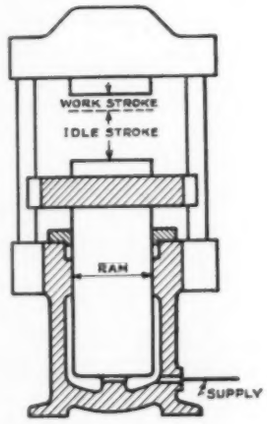


Figure 1 — The upworking press shown is one of the simplest types.

▲ IN THE application of hydraulic power, as a means for doing useful work, there have been many developments and improvements during the last decade, including:

1. New pump designs and controls, suitable for direct pumping, storage systems, or both.
2. Improved ram type accumulator designs.
3. The practical development of the gas loaded hydraulic storage accumulator, one particular application of which is the better known "air bottle-water hydraulic accumulator."

The improvements and developments listed represent such a wide range of application that many users and prospective users of such equipment often become confused regarding proper application; others develop biased viewpoints — often incorrectly taken.

For example, one hears that the only modern type of hydraulic machine is one using direct pumping, that is, a machine having direct motor driven pumps with all controls built into and an integral part of same. To one so convinced, all other hydraulic designs of systems are antiquated, or certainly not modern.

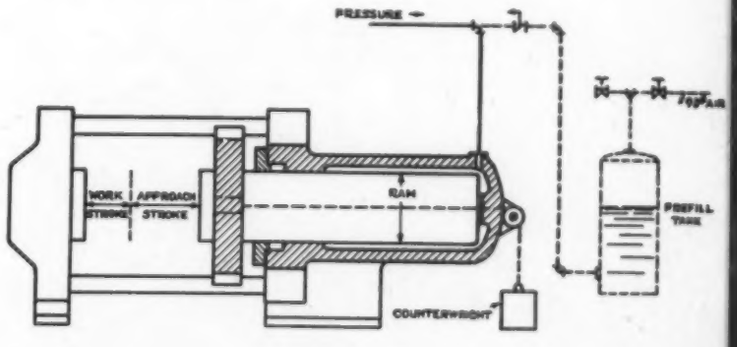
One also hears that the well known central storage system, with a weight loaded ram type accumulator, is the simplest and least over-all expensive per horse power delivered, and, therefore, best. Often such a person cannot be convinced to the contrary, in spite of facts.

The gas loaded bottle storage accumulator has its supporters, many who do not hesitate to state that by comparison the weight loaded accumulator is obsolete.

From experience most of us realize that it is easy to become oversold on new ideas. Apparent advantages of any new idea often apply to only local rather than general applications. In the subject under consideration, the apparent advantages of the self-contained direct pumping system as against a central storage system, or of a gas loaded storage system versus a ram type accumulator system, may and often do disappear into the impractical or uneconomical when the basic underlying fundamentals of a particular application are studied.

Actually, there are certain advantages in favor of direct pumping; certain advantages in favor of weighted accumulator storage systems; and certain advantages

Figure 2 — This simple horizontal press uses a counterweight return.



Presented before AISE Birmingham District Section Meeting, October 28, 1946

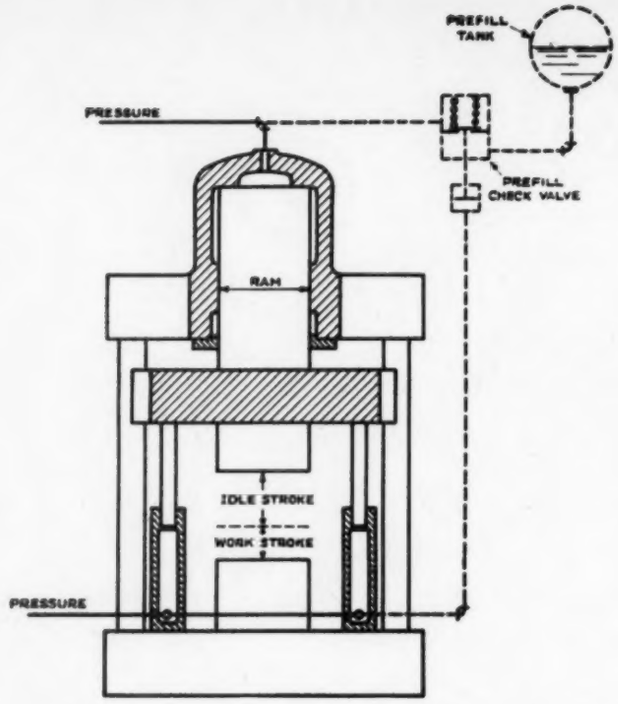


Figure 3 — This down working press has pushbacks.

in favor of the gas loaded bottle accumulator system. Each is the answer to certain system requirements.

To those who work with hydraulic systems constantly, there is no confusion. Their selection of any system for a specific application is based on fundamental requirements.

The underlying basic principles are all old and well known, but in view of the confusion which seems to exist to many users and prospective users of hydraulic power, a review of basic principles and designs used in the field of hydraulic power appears to be in order.

BASIC USES FOR HYDRAULIC POWER

What are the basic uses for hydraulic power as used in modern industry today? The majority of uses could be classified into four general groups.

1. In hydraulic machines for creating or maintaining a given force such as is required for:
   a. Forming, forging, drawing, coining, welding or pressing of metals.
   b. Manufacture of plastics including rubber products.
   c. Manufacture of plywood products.
   d. Manufacture of other composition products.
2. In moving or lifting of heavy loads, for example, elevators, mill lift tables, hydraulic cranes for large forging presses, blooming mill manipulators, furnace doors and covers, also many others. Machine tool applications, which represent a very highly developed field and which in itself would warrant a lengthy discussion, are included.
3. In applying hydraulic pressure directly to an object for such purposes as:
   a. Descaling of steel.
   b. Debarking of logs in the lumber industry.
   c. Separation of wood and other hydro-carbon fibres in the production of rope, hawsers, etc.
   d. Hydraulic mining.
4. In applying hydraulic pressure directly inside a vessel, for testing, expanding, collapsing, shrinking and other purposes.

While these four groups list widely divergent uses, the hydraulic power requirements have much the same general characteristics.

Further study of fundamentals, therefore, will deal with uses as relating to machines and applications most often encountered in industry, because of their familiarity and also because such uses represent the greatest proportion from the standpoint of developed horsepower in use.

TYPES OF BASIC APPLICATIONS OF HYDRAULIC POWER

Figures 1, 2, 3, 4, 5, and 6 illustrate several simple basic machines using, and similar applications of, hydraulic power. In each, the pressure fluid used produces motion, force, or both, for such purpose as the performing of useful work during processing of various materials. The hydraulic fluid may be water, oil, water containing soluble oil, or certain recently developed oil substitutes. The first three are most common.

Figure 1 represents an up-working type of hydraulic machine or press, one of the simplest possible forms. Hydraulic pressure, when applied, raises the ram. The return is by gravity, the weight of the moving parts forcing the fluid out to the sewer or sump. If this machine has a short idle stroke compared to the work stroke, frequently only high pressure fluid system is used. On the other hand, should there be a long approach stroke with a very short work stroke, a two-pressure system employing both low pressure for the idle stroke and high pressure for the work stroke is most common.

A relatively large low pressure volume feed in proportion to high pressure volume feed saves time and accomplishes a "rapid advance and return" to and from working position, much more a requirement in modern mass production than of production of thirty years ago.

Figure 2 represents a simple form of horizontal press, using counterweight for return. Again depending on actual hydraulic demand, a single or a two pressure system such as was described in previous paragraphs is most frequently applied.

A variation of this idea incorporates admitting and releasing air pressure to and from an auxiliary low

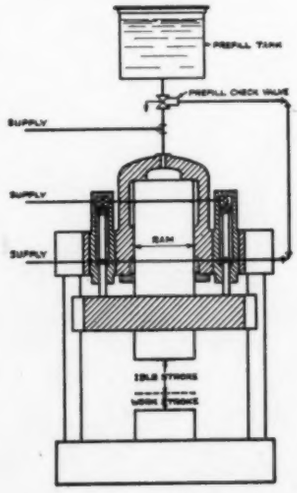


Figure 4 — The auxiliary side rams speed up movement of crosshead during idle or rapid advance stroke.

pressure storage tank to accomplish the fast approach and return strokes. High pressure is admitted to the main cylinder only for producing the work stroke. This system is frequently used in wheel press operation. It is apparent, however, that this design can also be applied to down-working and up-working machine requirements.

Figure 3 illustrates a simple down working press with pushbacks. Pushback cylinders are usually designed for high pressure fluid, but main cylinder may use a combination low and high pressure system.

A combination low and high pressure system usually implies two separate pumping units, one to furnish the low pressure and one to furnish the high pressure fluid. In a broad sense, such a description might well include the simple "prefilling system" shown as a combination of the equipment illustrated in both solid and dotted lines.

In the simple "prefilling system," press or machine crosshead drops by gravity when pushbacks are exhausted. During this idle or approach stroke, main cylinder is prefilled from overhead atmospheric or pressure tank through prefilling check valve. When idle stroke is completed, high pressure is applied to main cylinder to accomplish the work stroke. On return stroke, platen is lifted by pressure in pushback cylinders, and the prefill valve is opened by pressure to permit main cylinder to exhaust rapidly back into prefill tank.

Prefilling systems permit rapid ram movements during idle strokes, without use of separate low pressure pumping units and their attendant controls.

Figure 4 illustrates a down working press having similar characteristics to Figure 3. Differential auxiliary cylinders permit forced movement of press crosshead downward during idle or rapid advance stroke, sometimes advisable from standpoint of required idle stroke speed. Underside of auxiliary plungers can be operated from main pressure by valving or constant pressure. If constant pressure is used, the top areas must be larger to overcome the smaller lower side area. Prefilling is accomplished as in Figure 3.

This construction with properly designed cylinder areas can be converted by proper valving to a two or three tonnage press, producing a machine having faster speed and greater efficiency at lower tonnages for a given rate of pressure fluid flow.

Where one maximum size press must serve as economically as possible in place of three or four various tonnage units, this construction is usually the problem's answer, whether operating from a central storage system, or from a direct pumping system.

Figure 5 shows a typical application of hydraulic power fluid impinging directly against a surface or object for removal of scale from hot steel. Such applications are almost universal in steel and forging plants today. Water at 12-2500 psi is discharged through special nozzles in such a manner as to convert nozzle pressure into maximum velocity. High efficiency nozzles produce maximum impinging force with minimum horsepower and minimum cost per ton of steel descaled.

Gas loaded (air bottle) accumulator systems and centrifugal pumping equipment are most prevalent for steel mill use. Centrifugal or plunger type pumping equipment will be found in use for descaling forgings.

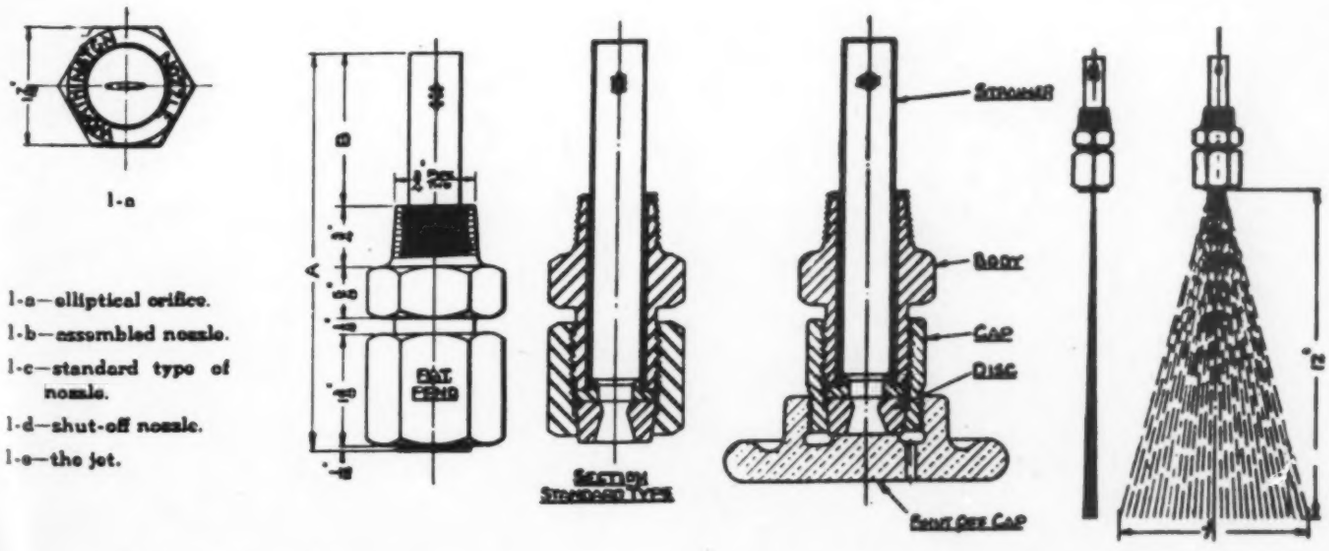
Figure 6 shows a simple form of tube or pipe tester, a typical application of pressure to the inside of a vessel for testing and other purposes.

A tube or pipe is sealed between a stationary and a movable head. The tube is then filled with low pressure fluid at the same time purging the tube of all air. After the tube is filled, high pressure is applied. A tube tester requires a large volume of low pressure fluid in proportion to high pressure fluid. A two pressure system, employing a low pressure central storage system in combination with a direct pumping high pressure unit equipped with adjustable pressure control, is most frequently the selected system.

PRINCIPLES GOVERNING HYDRAULIC POWER DEMAND

The six examples (Figures 1 to 6) illustrate practically all types of basic hydraulic power applications to

Figure 5 — Descaling of steel utilizes direct application of pressure.



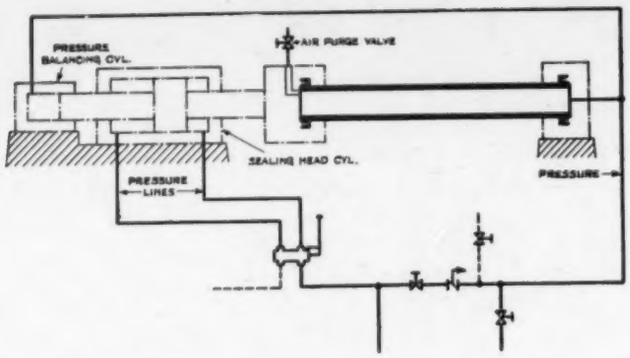


Figure 6 — Simple pipe or tube tester.

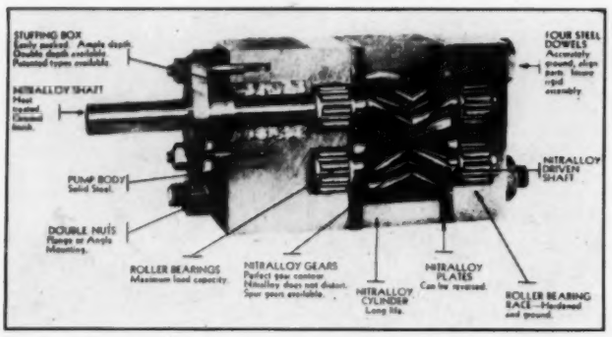


Figure 7 — The gear type pump requires close clearances and accurate machining.

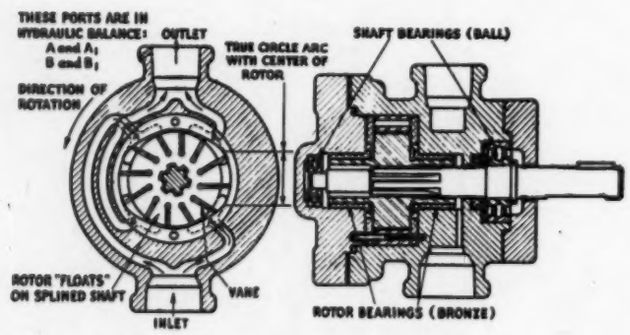

THESE PORTS ARE IN HYDRAULIC BALANCE: A and A1; B and B1
OUTLET
TRUE CIRCLE ARC WITH CENTER OF ROTOR
SHAFT BEARINGS (BALL)
DIRECTION OF ROTATION
ROTOR "FLOATS" ON SPLINED SHAFT
VANE
INLET
ROTOR BEARINGS (BRONZE)

Figure 8 — Vane type pump.

be found in use, but there are many modifications. Such modifications include combinations of cylinders in one or various planes, angular constructions, opposed constructions, and many others. Cylinders may be in any number whether for main or auxiliary purposes, depending on ultimate requirements. However these examples are representative of all basic hydraulic power applications and will serve to illustrate the various basic principles and characteristics of hydraulic fluid demand to be found in service.

In Figures 1 to 4 the basic principles of operation in each are the same. Force, and motion of a ram are required as follows:

1. During forward (work) stroke when
   a. Hydraulic power is applied to main ram for producing motion and for doing work.
   b. Hydraulic power may be required in a small amount for rapid advance.
2. During reverse stroke when
   a. Main cylinder is exhausted. Only infrequently is useful work done.
   b. Hydraulic power may be required for stripping.
   c. Hydraulic power may be required in a small amount to produce reverse action.
3. Motion in either direction may be required at variable or constant speed.
4. Rams may require idle periods during, or at ends, of stroke.
5. Force characteristics may be variable, constant, or intermittent.

Figures 5 and 6, while having different operation characteristics, have hydraulic requirements usually corresponding to the general requirements of one of the systems described under Figures 1 to 4.

Any system must be laid out and studied. Its exact flow and pressure characteristics require the selection of hydraulic units, best suited to meet the individual system requirements, if economical installations and operating costs are to be obtained.

TYPICAL HYDRAULIC GENERATING UNITS

There are many designs of hydraulic generating units or pumps in common use today. Each pump design has been developed because of some specific requirement. All designs have merit as can be proven by the fact that they perform satisfactorily to the user and the sales have proven satisfactory to the manufacturers.

Figure 7 shows one type high pressure gear pump. This type of pump depends on close clearances and accurate machining. Parts are usually made of nitralloy steel which is very hard. Such pumps can be obtained in large capacities for reasonably low pressures but this design is limited at the present time to small capacities for pressures ranging from 500 to 2000 psi maximum.

The gear pump for hydraulic service, has constant speed, constant capacity characteristics, and is not recommended for water service, its use being confined exclusively to oil.

Figure 8 illustrates a well known and widely used constant speed, constant capacity vane type pump. The center rotor, operating at constant speed, carries movable vanes which seal against the periphery and

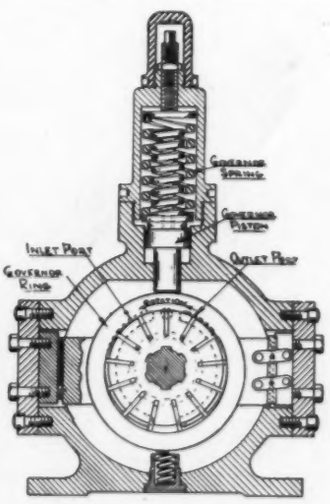


Figure 9 — Variable capacity vane type pump.

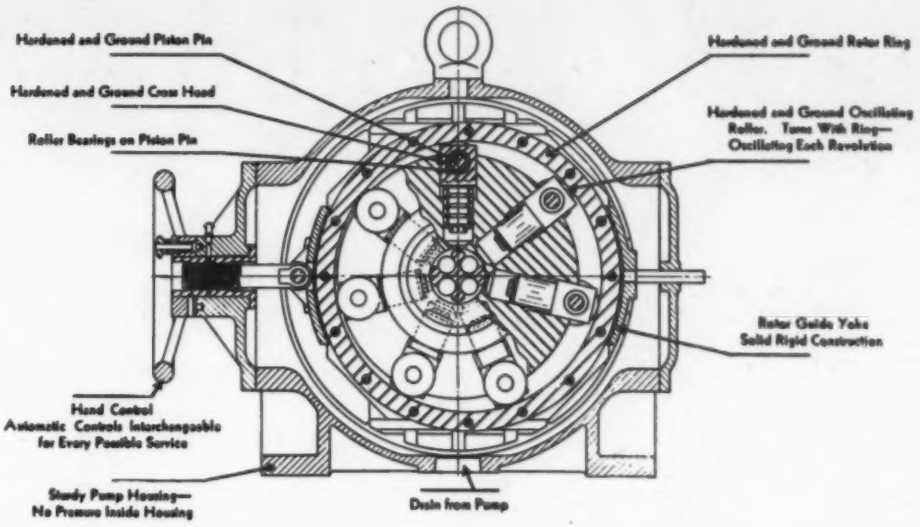

Hardened and Ground Piston Pin
Hardened and Ground Cross Head
Roller Bearings on Piston Pin
Hardened and Ground Rotor Ring
Hardened and Ground Oscillating Roller. Turns With Ring—Oscillates Each Revolution
Rotor Guide Yoke Solid Rigid Construction
Hand Control
Automatic Controls Interchangeable for Every Possible Service
Sturdy Pump Housing—No Pressure Inside Housing
Drain from Pump

Figure 10 — The radial piston pump can be easily adjusted to produce any capacity from zero to maximum.

sides of the pump casing. The contour of the inside of the casing, together with the special manner of porting, produces a constant discharge of fluid. Equal and opposing radial hydraulic thrust loads produce extremely light bearing loads. The practical elimination of bearing wear contributes in a major way to the success of this particular type of pump.

Pumps are obtainable in small or medium capacities. Single stage units are recommended for 1000 psi maximum pressure; two stage units are recommended for 2000 psi maximum working pressure. This design of pump is not suitable for water service, oil only can be used as a fluid medium. A wide selection of controls, which accomplish simple or complicated operations are obtainable.

Figure 9 illustrates another type of vane pump. By shifting the governor ring eccentric to the center of the rotor which carries the vanes, discharge of fluid is produced. The illustration shows this pump equipped with pressure control, permitting zero discharge at maximum pressure setting. This type of pump is designed for oil service, 1000 psi maximum working pressure and in medium size capacities. The shifting governor ring, which permits variable pressure or variable capacity, makes this design of pump applicable for many hydraulic services.

Figure 10 illustrates a well known radial piston type pump. The rotor, revolving around the center pintle carries a number of close fitting, packless, plungers which, in turn, oscillate by contacting a stationary or movable, hardened and ground rotor ring. The illustration shows the rotor ring shifted for maximum discharge. Hand wheel adjustment permits shifting of rotor ring to the left. When so shifted, center of rotor ring can be made to coincide with center of rotor, thus producing no movement of pump plungers which, in turn, reduces capacity to zero. This type of pump is suitable for oil service only. Pressures of 2500 to 3000 psi maximum are recommended but for extremely difficult service, lower pressures are suggested.

The illustration shows the hand wheel adjustable volume control, permitting manual setting to produce any capacity from zero to maximum. Other types of controls include variable pressure controls, variable pressure-variable volume controls, reversing controls, and many variations of same. Such controls have been developed to include manual, semi-automatic and automatic operation.

Figure 11 illustrates one of the widely used controls which make this type of pump so popular and useful. The upper left hand view shows slide block, rotor and reaction ring unit with its centerline moved to left of cylinder, pintle and drive shaft centerline. Oil is delivered through upper port. Lower center view shows slide block, rotor and reaction ring unit with its centerline concentric with cylinder, pintle and drive shaft centerline. In this neutral position, no oil is delivered. Upper right hand view shows slide block, rotor and reaction ring unit with its centerline moved to right of cylinder, pintle and drive shaft centerline. Oil is delivered through lower port. It is possible to control the position and movement of this slide block very accurately. Manual, semi-automatic and automatic controls permit oil delivery to be varied smoothly over a stepless range in either direction from zero to maximum. The advantages of such a design, with suitable controls when applied to certain machine requirements, are apparent.

Figure 12 shows two views of a pump, which is also a radial piston type design. Centrifugal force maintains the plunger rollers in contact with an eliptical reaction ring, but a simple spring type of plunger return means is incorporated to assure plunger return when pumps are operating below adequate centrifugal force speed, approximately 100 rpm.

The plungers are fitted to cylinders in a rotor in one or more banks of eleven plungers per bank.

The rotor rotates on a fixed pintle which has suitable ducts and ports for directing the oil inlet into those cylinders passing through two opposite quadrants and also for directing the oil delivery out of those cylinders passing through the other two opposite quadrants.

Each plunger makes two inlet and two delivery strokes per revolution. A sturdy equalizing axle journaling a roller at each end is universally attached to the outer end of each plunger. This unique construction provides ample bearing areas for the plunger load components exerted radially and rotatively on the axle bearing surfaces and insures zero side loading of the plunger.

In variable delivery pumps, two banks of eleven

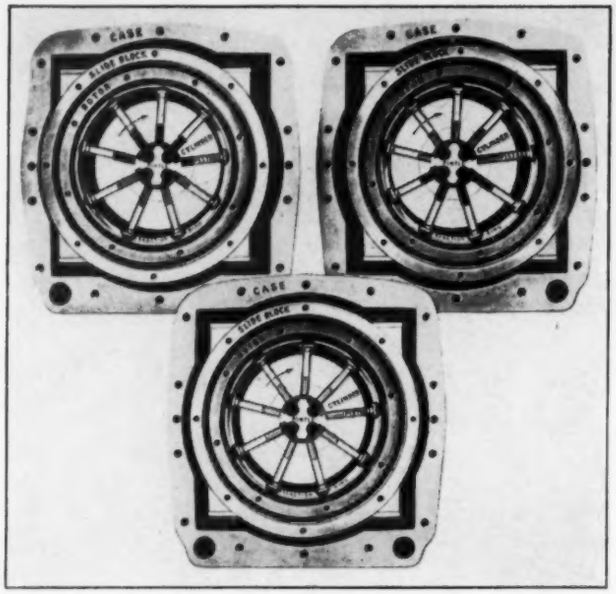


Figure 11 — This sketch illustrates the variable displacement characteristics of the radial piston pump.

plungers each are arranged in a single rotor. The plungers in the two banks are arranged in parallel relation. Each pair of parallel cylinders is in open communication by means of a drilled passage in the rotor.

The plunger rollers of each bank roll against a separate elliptical reaction ring. These reaction rings are rotatably mounted in the pump housing and are geared together so that they rotate in opposite directions in response to rotation of the volume control gear.

At full delivery, the major axes of the elliptical reaction rings are parallel and at zero delivery, the major axes are 90 degrees apart. Under the latter condition, the net delivery stroke is zero since the displacement of the plungers moving radially outwardly exactly equals the displacement of the plungers moving radially inwardly in both delivery quadrants and both suction quadrants.

As the angle between the major axes is reduced from 90 degrees, the net plunger displacement increases. When this angle becomes 0 degrees, the major axes are parallel and both plungers of a pair of parallel plungers reciprocate in phase through full delivery and suction strokes.

Plunger reaction loads exerted on the elliptical reaction rings are balanced through the volume control gear, the torque of one reaction ring balancing that of the other. Thus light and sensitive manual or automatic pressure and volume controls can be interchangeably employed.

Variable delivery pumps are equipped with any one of a number of different type volume controls which are interchangeably mounted on the pump. The sensitive manual dial type control may be mounted on either side of the pump. The surge-proof balanced pressure compensator is constructed to mount on either side of the pump with a volume dial indicator mounted on the side opposite the pressure compensator.

A small oil circulating pump is incorporated for the purpose of circulating oil under near zero pressure direct from the oil tank through the pump housing and back to the tank. This insures sufficiently low pump housing temperatures of the variable delivery pump under the condition of extreme pressure operation at zero or near zero delivery.

This pump is designed for constant duty service and for working pressures up to 5000 psi.

Due to the high pressure this pump can develop continuously; its extreme compactness (a 40 horsepower pump delivering 12 gpm at 5000 psi is only 9 inches in diameter); and its ability to operate at direct drive motor speeds (1170-875-700-580 rpm); this pump has many uses wherever hydraulic power is required.

Figure 13 is a cross-section of a recently announced pump of a radial piston type design, which instead of incorporating the usual pintle valving, uses hydraulically operated inlet and outlet ball check valves.

Seven piston assemblies, each comprising a hollow piston, cylinder sleeve, inlet valve, and cam follower, are equally spaced radially around the periphery of the pump body and motion is transmitted to the pistons by an eccentric shaft, rigidly supported on two needle bearings, one on each side of the eccentric cam.

The flanged foot of the piston bears on a third needle roller bearing, which floats on the eccentric cam. The eccentric shaft is held against longitudinal movement by a double ball radial thrust bearing mounted in the motor end cover plate. This bearing also serves to support the cantilever load when a belt or gear drive is used. Shaft seals prevent air infiltration into fluid while pump is in operation, also loss of oil by leakage when pump is not in operation.

The oil circuit within the pump may be described briefly as follows:

Oil passes through the inlet cage to the crankcase which is hermetically sealed by the two shaft seals, one on either side of the double ball radial thrust bearing in the motor end cover plate. As the hollow piston moves down, inlet ball check valve inside of piston opens, permitting the piston to fill with oil until the motion of the piston reverses, at which point the inlet check closes, trapping the piston full of oil. As the hollow piston moves up, the oil is forced out through the discharge ball check valve to the hydraulic manifold and thence out of the pump. Since the pistons are hollow, the higher the pressure, the tighter the seal between the moving pistons, cylinder walls, and pump body which results in the induction of extremely high pressure.

The inlet characteristics of these radial hydraulic pumps are similar to those of centrifugal pumps. They are not self-priming; and to insure the best results, they should be installed below the oil reservoir supply where gravity will automatically keep them primed. After priming they will maintain a vacuum of 20-25 inches of mercury, providing the inlet line is air tight. They can be run in either direction at will, which means that there is no chance of installation being in the wrong direction.

These radial hydraulic pumps with their ability to generate pressures up to 10,000 psi offer new possibilities in the design of oil hydraulic circuits. Pumps are compact, easily maintained, ruggedly built and operate at 1750 rpm direct motor speed. Constant discharge capacity characteristics require special bypass controls, pressure differential motor start-stop controls, variable

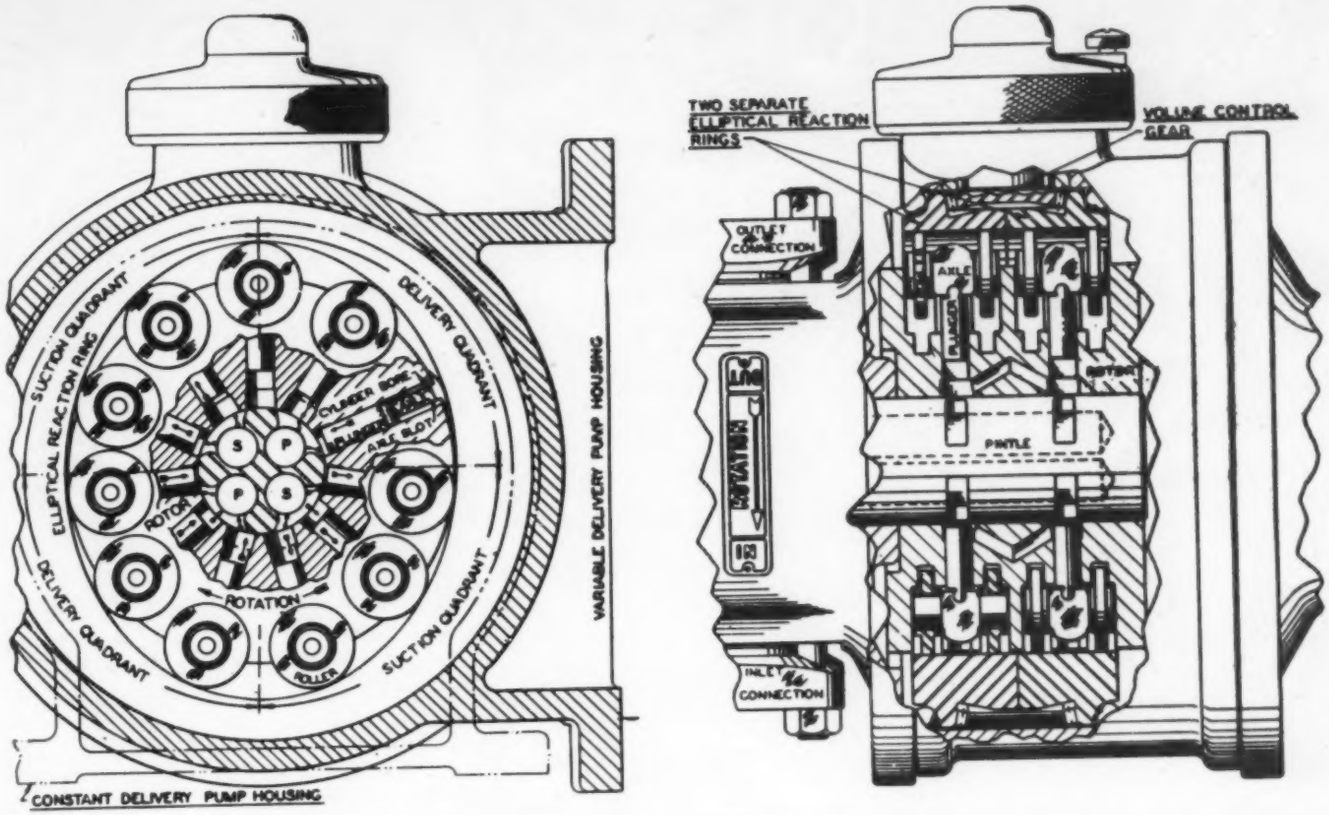


Figure 12 — The high pressure radial piston type pump shown has special variable volume and pressure controls.

speed transmissions, pressure relief controls, or similar, for automatic and continuous operation.

Figure 14 illustrates a centrifugal pump. The illustration shows an eight stage unit. This particular type of pump, however, has been designed for use in connection with press operation where the operating pressure has been as high as 6000 psi. The centrifugal pump is extremely compact for a given discharge capacity. Water or water containing a slight amount of soluble oil is usually the fluid medium recommended. While the centrifugal pump is a constant speed unit, it has variable discharge characteristics which vary with the discharge head. If demand fluctuates only to a limited degree from average demand, the centrifugal pump should be considered as a possible application of direct pumping. Provisions must be made to guard against overheating during periods of no demand to prevent possible damage to the pumping unit.

For pressures under 1500 psi, many improvements have been made in the last twenty years, and centrifugal pumps are now used in many places where they were previously considered unacceptable. There is a possibility that this type of pump will be more favorably considered and used in the future on installations requiring medium or extremely large capacities where the pressure may even exceed 7500 psi.

Figure 15 shows a small, modern design, standard, vertical, single acting, triplex plunger pump, having plungers provided with standard adjustable packing boxes, the basic design of which is familiar to all users of hydraulic pressure.

This type of pump, and similar horizontal designs, is suitable for small, medium and large capacities and all practical working pressures. Recent developments have resulted in larger discharge capacities for pumps of given physical dimensions. Higher plunger speeds and better valve designs are responsible. Where operating pressures are over 2500 psi, practically all present hydraulic systems are equipped with pumps of these general characteristics. In general, this type of pump can be considered as having constant speed, constant capacity characteristics.

Controls for reciprocating power pumps are mostly based on by-passing entire capacity at low pressure or pumping excess maximum pressure capacity over a relief valve. The latter is simple but in many cases, wasteful and such control is only rarely used. By-pass valves operated manually, semi-automatically, or automatically, are most commonly used. Such by-pass valves are designed as to permit discharge of entire pump capacity back into the exhaust system during idle periods. Many of the older types of by-pass controls were inefficiently designed. Modern designs of pump by-pass valves eliminate the deficiency of older designs and permit loading and unloading of pumps with minimum of shock and maintenance. Figure 16 shows an outside view of the pump illustrated in Figure 15.

Figure 17 diagrammatically illustrates a large horizontal, double acting, duplex power pump equipped with a suction valve synchronized unloaded, known to many hydraulic users as the Holveck unloader. With this device, motor and pump operate continuously, the pump being unloaded and loaded by means of the suction valves being maintained either inoperative or operative. Synchronized unloading is the interruption of the pump delivery in such a manner that unloading is accomplished by a gradual deceleration of fluid delivery and power input from full to zero, coinciding with the

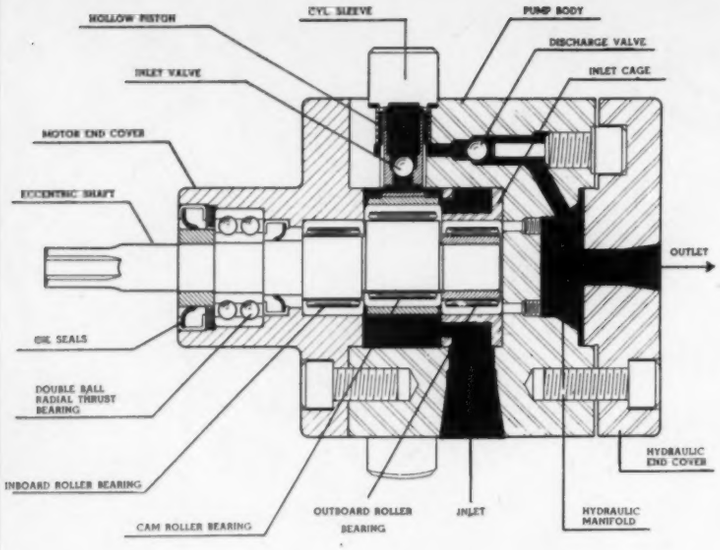


Figure 13 — Cross-section of a radial piston type pump.

diminishing rate of flow of the last plunger displacement. Synchronized loading is the resumption of the pump delivery in such a manner that loading is accomplished by a gradual acceleration of fluid delivery and power input from zero to full, coinciding with the increasing rate of flow of the first plunger displacement into the pressure system. In other words, unloading is accomplished at the end of the discharge stroke of the last plunger and loading commences at the beginning of the discharge stroke of the first plunger. This basic and inherent characteristic reduces possible shock to a very minimum. Another feature of this control is the short element of time required for unloading and loading, usually the time being less than is required for half a pump revolution. This device may be controlled electrically as, for example, by means of a pressure governor, permitting many manual, semi-automatic or automatic applications to hydraulic systems.

Figures 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17 illustrate practically all of the basic pump designs to be found in commercial installations. There are, naturally, many variations of these several designs. It has been considered unnecessary to describe all because the similarity of basic principles will be apparent to every one. It is important to note that in the designs previously described, pumps are available for practically any hydraulic service requirements to be found in industry.

Since some pumps are not practical in small sizes; since other designs are only suitable for the use of oil; since some designs have maximum pressure characteristics of 1000, 2000, 3000, 5000, or 10,000 psi; since some units require large amounts of floor space which may not be available, it is necessary that a pumping unit to be used in a given hydraulic system, be selected with care to be certain that satisfactory operating results will be obtained.

TYPICAL STORAGE ACCUMULATORS

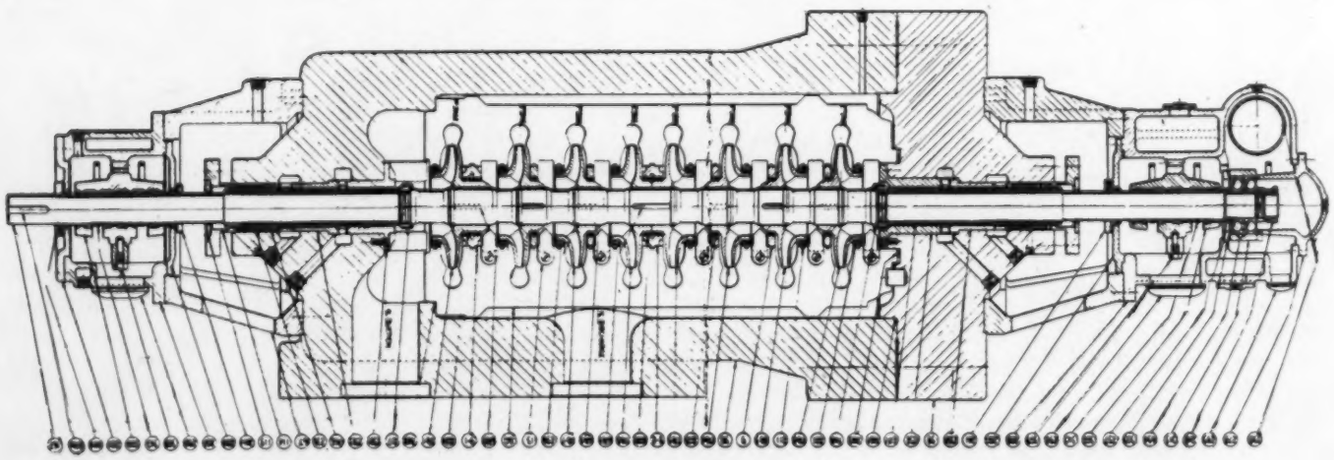
The hydraulic accumulator is a suitable vessel or tank so arranged that hydraulic fluid under selected pressure is stored during idle periods for instant use as required.

Very few hydraulic systems have a steady unvarying demand. To make maximum use of pumping equipment, where demand varies greatly, means must be provided to store up excess capacity during idle periods and make use of that stored up capacity during periods of excessive demand. Smaller pumps and motors operating at a high percentage of cycle time, result in greater pump efficiency and lower operating costs. It is not unusual to discover lower initial installation cost, also lower power cost, the latter due to reduction in peak and average electric current demands.

Figure 18 shows a typical weight loaded hydraulic accumulator, built in accordance with present day practice. When designed, emphasis has been placed on rugged construction, accessibility for proper lubrication, means for lubrication of the ram and packing, maintenance of ram alignment by proper guiding, and provision for removal of ram or cylinder without dismantling tank or removing ballast should trouble of such a nature develop that this were found necessary.

A cast steel cylinder, flanged to a substantial base, is provided with a meehanite or forged steel ram, to the top of which is fastened a crosshead. This crosshead, in turn, supports the ballast tank. A bronze, or equiva-

Figure 14 — This high pressure centrifugal pump has eight stages.



lent, throat bushing in the cylinder together with adjustable roller guides on the tank bottom co-acting against machined guide strips on the outside of the cylinder provides means for maintaining necessary alignment of ram in the cylinder.

Proper pressure is produced by filling the ballast tank with required weight of ballast.

Ram is prevented from being inadvertently forced out through the top of the cylinder by suitable, properly placed, release holes.

Many uses for weighted accumulators have been found during the last several years. Usual available capacities range from one gallon to 500 gallons at pressures from 500 to 5000 psi. Units of 30 to 100 gallons capacity and 500 to 3000 psi pressure are extremely numerous for roll balance and other such services because of their simplicity, low first cost, low maintenance and freedom from necessity of requiring skilled operation attendants.

Figure 19 shows an air piston type of hydraulic storage accumulator. In this unit, air pressure at 50 to 250 psi pressure provides the necessary ballast force to produce the required hydraulic pressure on the fluid in the lower cylinder. Hydraulic fluid discharges through hole in center of hydraulic ram to opening just above base casting from where it is piped to machines to be served.

The air piston type hydraulic accumulator operates on the principle of expansion and contraction of air in a closed system. Air connection at top is piped to a predetermined size reservoir. As hydraulic pressure fluid is used, the trapped air expands with a corresponding drop in pressure. When hydraulic fluid is replaced by the pump, the trapped air contracts. It is evident that air storage tank must be of sufficient size to permit pressure variations within system limitations.

Air piston type hydraulic accumulators are compact and have been widely used for capacities up to 15 gallons at 5000 psi or 75 gallons at correspondingly lower pressures.

It is apparent that such a unit would find many uses in experimental work where different hydraulic pressures are required at different times. Increasing or decreasing the air pressure changes proportionately the hydraulic fluid pressure.

Figure 20 illustrates the simple gasloaded or more widely known air bottle type storage accumulator. While only one vessel is shown, any number can be connected together into a common system to give the volume necessary for the displacement required.

The space above the normal water level is charged with air or some other gas at the required pressure where it remains trapped. When fluid is withdrawn from the vessel, the gas expands, with a corresponding drop in pressure. Replacement of the fluid causes the gas to contract with a corresponding drop in pressure. Replacement of the fluid causes the gas to contract with a corresponding increase in pressure.

Most systems of this kind are based on an allowable pressure difference of 10 per cent between P2 and P3. This 10 per cent pressure variation determines the normal accumulator displacement shown cross sectioned between V2 and V3 and this displacement, in turn, should be the equivalent of the maximum system demand as determined from flow charts.

While we have mentioned 10 per cent as an allowable variation in hydraulic pressure, some systems permit only 5 while others permit 20 per cent variation. The greater the allowable pressure variation, the less expensive the system becomes. Decreasing the allowable pressure variation unnecessarily adds greatly to the initial cost.

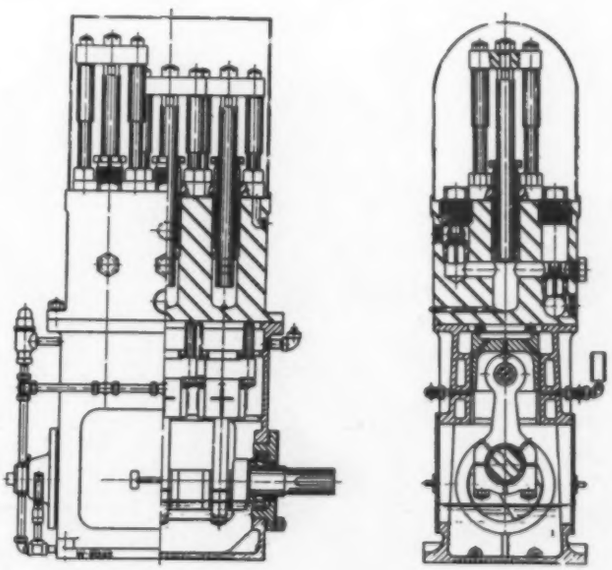
Gas loaded or hydro-pneumatic accumulators, as they are usually termed, are obtainable in practically all sizes required. Larger sizes show greatest advantages compared to other storage units. Small sizes often prove extremely expensive due to cost of necessary auxiliaries.

The advantages include:

1. Minimum of floor space.
2. Absence of moving parts.
3. Practical elimination of inertia shock.
4. Tendency to absorb system shock.
5. Minimum of foundation expense.
6. Ability to change system pressure as required.

It is extremely important that the hydro-pneumatic accumulator, as it has become known, be equipped with necessary accessories to prevent damage, and provide easy, quick and efficient maintenance. High and low safety levels require means for stopping pumps to prevent excessive pressure, and automatic valve control to prevent loss of air, with attendant troubles, into the distribution system should pumps fail, leakage develop, or a line break. A high pressure air compressor is required for replacing air leakage even though it is known that this is usually an almost negligible quantity. Means for checking actual level of fluid in bottle with required corresponding pressure; valving to permit recharging while system is in operation; suitable high and low level alarms; valves for draining vessels; all are required if a smooth working, efficient system with minimum shutdown time, is desired.

Figure 15 — Standard triplex power pump.



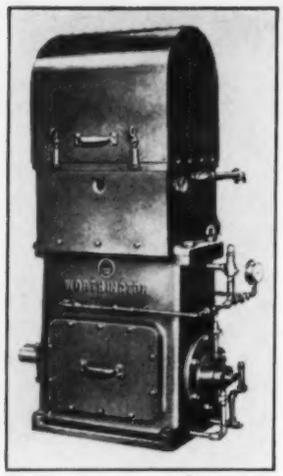


Figure 16 — Outside view of vertical triplex power pump.

TYPICAL HYDRAULIC SYSTEM POWER-FLOW DEMANDS

Figure 21 illustrates a characteristic hydraulic fluid demand of a single machine, which may be applied to any of the three types of machines shown in Figures 1, 2, 3, 4, and 6. In this case, the clearance stroke is taken up by a separate low pressure system. High pressure fluid at constant pressure is supplied to the main ram during the working stroke and the pull back rams during the return stroke. The average rates of flow of the high pressure fluid are represented by values A, B, C, and the low pressure rates of flow by values (a) and (b). This particular chart shows a considerable excess in the rate of flow during the working stroke, represented by the value A, over the calculated average rate of flow for the complete cycle, represented by the value B. The excess value of A over B, as compared to the ratio A/B = 1, is a determining factor in the selection of either an accumulator system or a direct pumping system.

In this particular fluid demand, which is not uncommon, the value of the ratio A/B = 2.8 indicates that for a direct system the pump capacity would have to be 2.8 times greater than the pump capacity in an accumulator system. The value of this ration in some cases may be greater, being as high as or higher than A/B = 5.

The determining factor A/B applies to the low pressure fluid demand as represented by the value of the ratio a/b. In this case the value of a/b = 10, necessitates a system capable of supplying this peak demand.

Fluid demands as illustrated in Figure 21, normally favor the storage accumulator system for high pressure, with accumulator or prefilling system for low pressure. Selection of low pressure type system depends to some extent on quantity required.

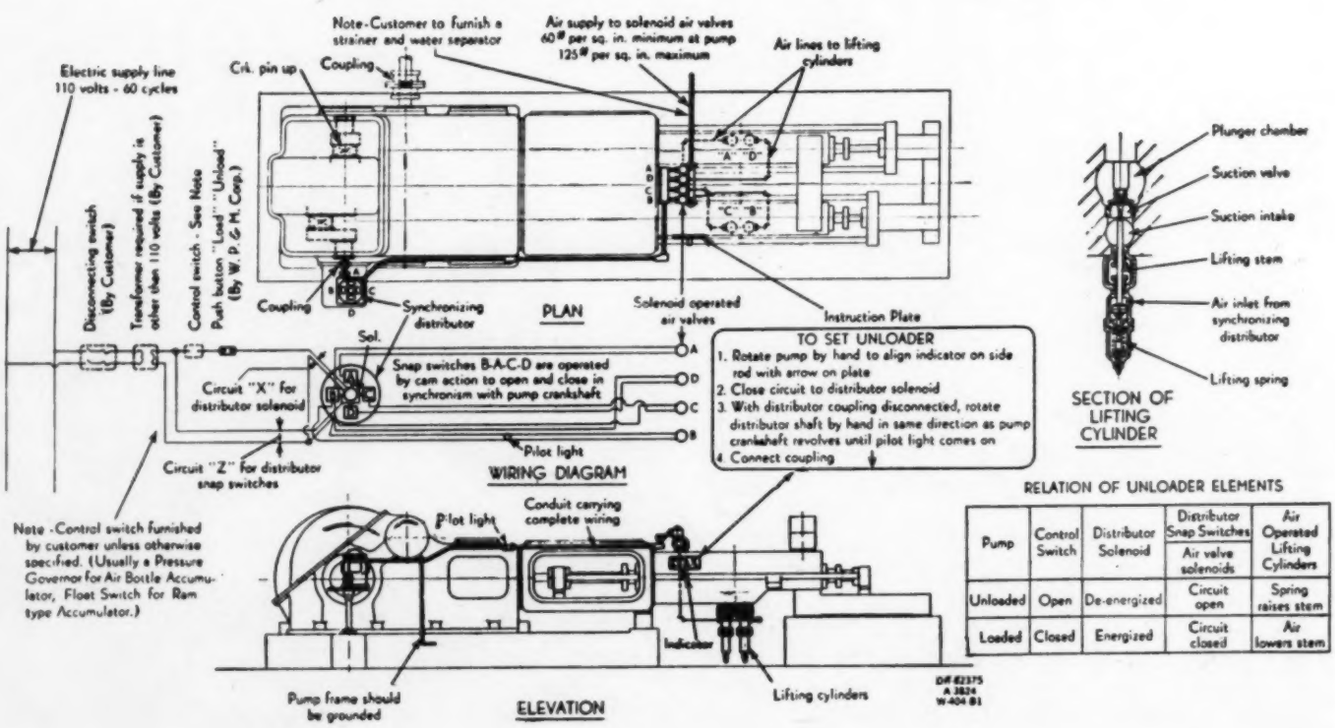
There are several factors, however, which may influence selection of accumulator system as against direct pumping. These are:

1. First cost of generating unit plus first cost of installation.
2. Operating plus maintenance costs.

Figure 21 illustrates a characteristic hydraulic fluid demand in which the value of the ratio factor A/B = 1.35 for the high pressure system. In this case the variable capacity pump in the direct system is only 1.35 greater than the pump required in the accumulator system. A condition having a ratio factor of 1.35 may not warrant the accumulator type of system from the standpoint of first cost and economy of operation.

The character of the fluid demand for the low pressure condition favors the accumulator or prefilling in large

Figure 17 — Schematic diagram of horizontal, double acting, duplex power pump.


Note-Customer to furnish a strainer and water separator
Air supply to solenoid air valves 60# per sq. in. minimum at pump 125# per sq. in. maximum
Air lines to lifting cylinders
Electric supply line 110 volts - 60 cycles
Crk. pin up
Coupling
Disconnecting switch (By Customer)
Transformer required if supply is other than 110 volts (By Customer)
Control switch - See Note
Push button "Load" "Unload" (By W. P. & H. Corp.)
Coupling
Synchronizing distributor
PLAN
Solenoid operated air valves
Instruction Plate
Sol.
Snap switches B-A-C-D are operated by cam action to open and close in synchronism with pump crankshaft
Circuit "X" for distributor solenoid
Circuit "Z" for distributor snap switches
Pilot light
WIRING DIAGRAM
TO SET UNLOADER
1. Rotate pump by hand to align indicator on side rod with arrow on plate
2. Close circuit to distributor solenoid
3. With distributor coupling disconnected, rotate distributor shaft by hand in same direction as pump crankshaft revolves until pilot light comes on
4. Connect coupling
Plunger chamber
Suction valve
Suction intake
Lifting stem
Air inlet from synchronizing distributor
Lifting spring
SECTION OF LIFTING CYLINDER
Note - Control switch furnished by customer unless otherwise specified. (Usually a Pressure Governor for Air Bottle Accumulator, Float Switch for Ram type Accumulator.)
Pilot light
Conduit carrying complete wiring
Indicator
Pump frame should be grounded
ELEVATION
Lifting cylinders
RELATION OF UNLOADER ELEMENTS
Pump | Control Switch | Distributor Solenoid | Distributor Snap Switches Air valve solenoids | Air Operated Lifting Cylinders
Unloaded | Open | De-energized | Circuit open | Spring raises stem
Loaded | Closed | Energized | Circuit closed | Air lowers stem

systems but in small systems, direct pumping may be the proper answer.

A study of the Figure 21 flow charts develops the fact that the closer the value of the ratio A/B is to unity, the more favorable is the selection of the direct pumping system.

Where two or more machines are supplied with hydraulic power from a central system, the fluid demand of each machine is plotted against time and the flow demands superimposed on one chart as illustrated in Figure 22.

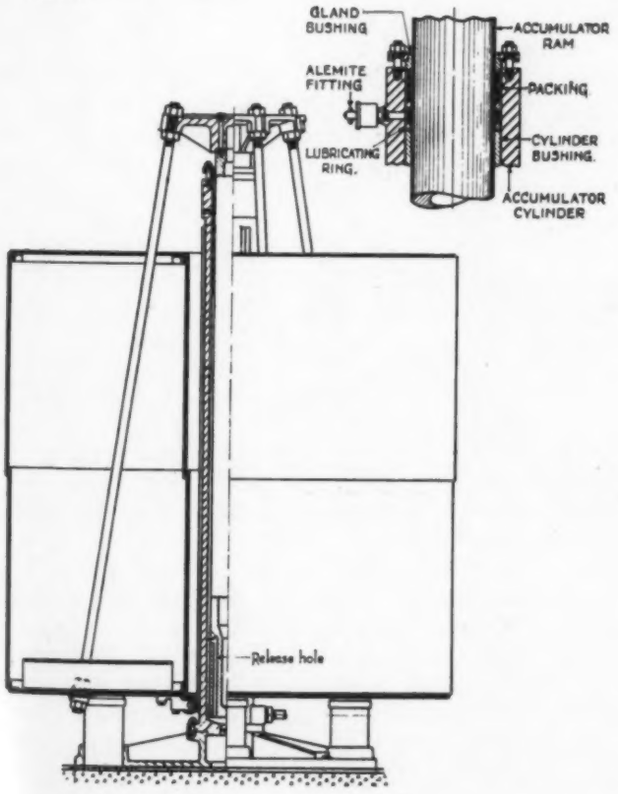
In Figure 22 the high pressure demand is plotted for the maximum condition for a given time to determine the maximum capacity of the hydraulic generating unit. Where a low pressure system is also involved the same method is employed to determine the size of the generating unit.

In this case, as in the previous ones, the determining factor of the type of system depends upon the value of the ratio factor A/B. This character of fluid demand, as shown in Figure 22 usually requires excess peak demands of short duration favoring the accumulator system.

Another type of demand is illustrated in Figure 23. This involves a central system, supplying hydraulic power to multiple machines at constant pressure, in which the cycles of operation are comparatively long. These machines which have long working strokes, the duration of which extends into minutes, are usually those used for extrusion and like processes.

In this type of fluid demand, the rate of flow represented by c-d which is the 100 per cent demand for all machines, may consume two or three minutes. The rate of flow represented by e-f is the demand for 50 per cent of the machines and the duration of this demand may also be two or three minutes.

Figure 18 — Standard ballast weighted hydraulic accumulator.



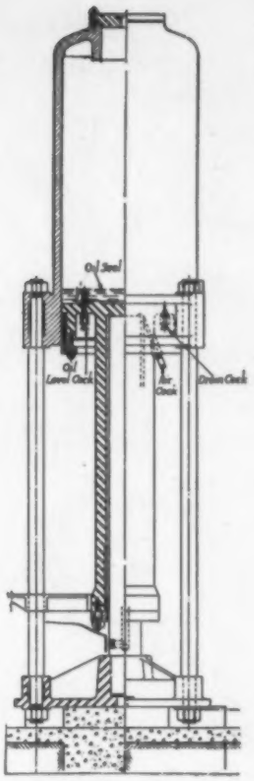


Figure 19 — Standard air piston type accumulator.

To meet this type of fluid demand, any of the following are the proper selection depending on size and conditions.

1. Centrifugal pump, no accumulator.
2. Vane type pump, with automatic volume control.
3. Radial piston pump, with automatic volume control.
4. Reciprocating pump, variable capacity type.
5. Suitable constant volume pump with accumulators and suitable controls.

Figure 24 illustrates hydraulic fluid demand required by a modern high speed forging press. Both charts show same total requirements of low and high pressure fluids but right hand chart illustrates a condition where rate of high pressure demand is double that illustrated on left hand chart. Switching from one production job to another frequently produces such a requirement.

The actual fluid requirements of this system were large for both clearance and work portions of stroke.

Selection of an air bottle accumulator system for high pressure — combined with prefilling from a low pressure storage tank, answers these and many other similar requirements.

Figures 21, 22, 23 and 24 point out the necessity of determining the power flow demand of a system before arbitrarily selecting the type of hydraulic system, pump unit or both. Some systems are so simple that the answer is obvious but most system requirements should be given careful consideration before writing the final answer.

BASIC HYDRAULIC GENERATING SYSTEMS

There are only two common general types of hydraulic power generating systems:

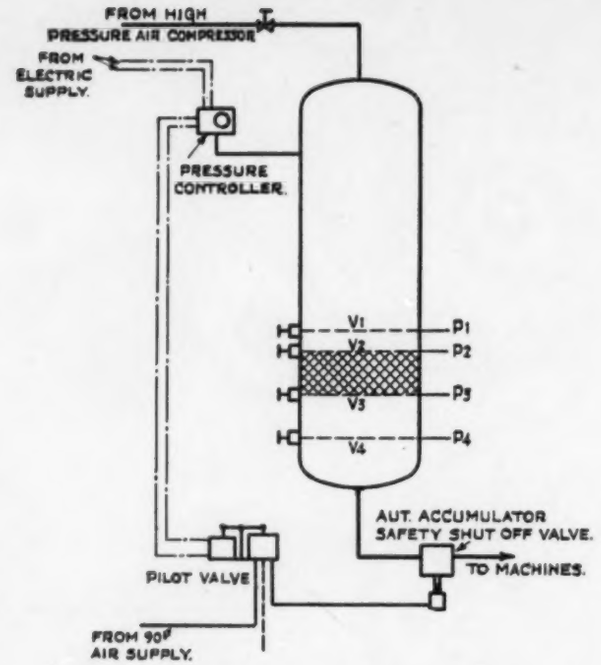


Figure 20 — The air bottle type hydraulic storage accumulator may use one or more vessels.

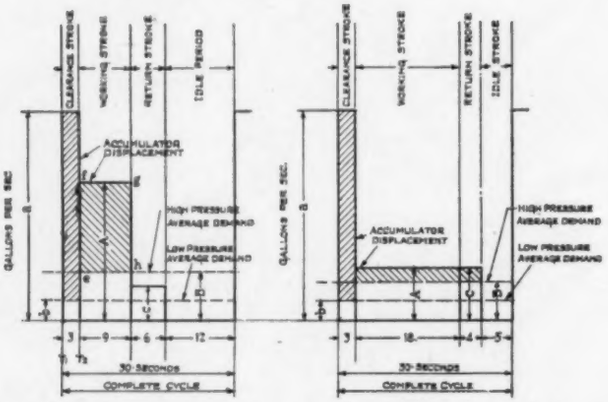
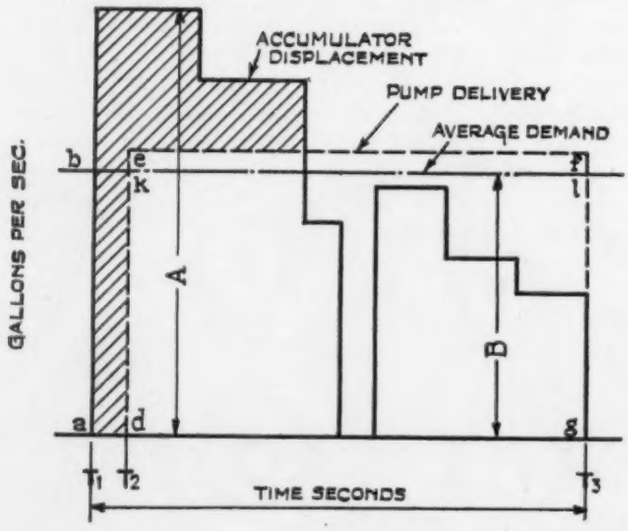


Figure 21 — This demand chart shows that an accumulator system would reduce the required pump capacity.

Figure 22 — Excess peak demands of short duration favors the accumulator system.



1. The direct pumping system.
2. The accumulator or central storage system.

There are many combinations of hydraulic power generation units applicable to each. A general listing of each follows:

1. Direct pumping, using
   a. Single pressure system with the following types of pumps.
      A. Gear pumps, constant speed, constant capacity.
      B. Vane pump, constant speed, constant or variable capacity.
      C. Rotary piston pumps, radial or axial flow types, constant speed, constant or variable capacity.
      D. Centrifugal pumps, constant speed, variable capacity.
      E. Standard reciprocating, constant speed, constant or variable capacity.
      F. Other designs.
   b. Two pressure system using:
      A. Two gear pumps.
      B. Two vane pumps.
      C. Two radial or axial flow piston pumps.
      D. Two centrifugal pumps.
      E. Two reciprocating plunger pumps.
      F. Various combinations of A, B, C, D, and E.
      G. Other combinations.
2. Storage or accumulator system.
   There are three types of hydraulic accumulator systems in general use.
   a. The weight loaded accumulator.
   b. The air piston type, sometimes referred to as the hydro-pneumatic type. To others it is known as an air piston intensifier type of hydraulic accumulator.
   c. The gas loaded bottle type accumulator.

Examples of each type can be found in service, powered by all of the types of pumps listed under direct pumping systems.

To many, the previous itemization of basic hydraulic systems and their many types of generation units, is entirely understood without further explanation. But to explain more clearly to others, a number of common hydraulic circuits applicable to the two basic systems follow.

Figure 25 illustrates a machine employing direct pumping and using a single constant speed pump. This pump could be of the standard reciprocating, the vane, the gear, the rotary piston or centrifugal type. Ram motion is controlled by means of a 4-way valve, open center type, permitting upward or downward motion or a neutral stationary position.

To limit the pump to maximum pressure for which the system is designed, an automatic relief valve opens at set pressure to discharge excess pump capacity back to the sump.

Such a system should only be used where there is a small idle stroke, or where infrequent use will produce little inefficiency from standpoint of total power used.

Care must also be taken to avoid holding maximum pressure on machine and discharging over the safety valve for long periods of time. This consumes power uselessly and may cause excessive and dangerous heating of the system fluid. In some cases a different control

should be selected. In practically all systems of this type, installation of a suitable size cooler is suggested to keep the temperature of the system within safe working limits.

Should a centrifugal pump be used, no relief valve is necessary. Centrifugal pumps produce a maximum shut off pressure. A closed center type of control valve, and necessary bleeding of pressure to prevent damage to rotor from excessive heat generated during dead shut off, furnishes a satisfactory control.

In place of pumping over a relief valve, as is necessary with constant speed, constant delivery type pumps, constant speed variable capacity pumps listed under A, B and D, equipped with special maximum pressure, no discharge controls can be substituted. Over-all cost per year of operation or per unit of production may be the determining factor. Variable volume controls can also be included, if beneficial to the ultimate machine requirement.

Figure 26 illustrates a machine employing direct pumping and using a single constant speed pump with eccentric ring shifting to produce zero to maximum flow in either direction. (See Figure 11.) The oilgear pump and circuit shown presents a typical rotary radial piston pump application.

Depressing hand lever or foot pedal causes ram to move down at a speed dependent on the amount of movement of the control. Any speed from zero to maximum, in either direction, is obtained at will.

Releasing the control reverses ram motion. Operator can start, stop, or reverse, press ram instantly. Collars on control rod limit ram stroke upward and can be present for any length of stroke desired, up to maximum for which machine is designed.

No external control valves, foot valves, relief valves or accessories are required. Only two pipe lines are necessary.

As in Figure 25 this system should be used only where there is a small idle stroke, or where infrequent use will produce little inefficiency from standpoint of total power used.

Figure 27 shows a machine having a two pressure direct pumping requirement. Both low and high pressure pumps are driven from a single, double end shaft motor and have constant speed characteristics. Practically all combinations of pumps are possible. For example, both low and high pressure units may be of the gear type, constant capacity vane type, rotary piston type, reciprocating type or various combinations of all types mentioned.

Two pressure pumping units, as shown, are very good, especially for small and medium capacities. When operator closes the control valve, discharge from both pumps is directed into the press cylinder. Ram moves under a pressure less than the setting of the unloading valve for the low pressure pump. When platen meets resistance, pressure is built up in the cylinder to the pre-determined unloading pressure of the low pressure pump unloading valve. When this pressure is reached, entire capacity of low pressure pump is returned to the suction tank.

High pressure pump continues to supply pressure for work stroke until operation is completed. When operator opens the control valve, both pumps by-pass their entire capacities to the suction tank. Operating valve,

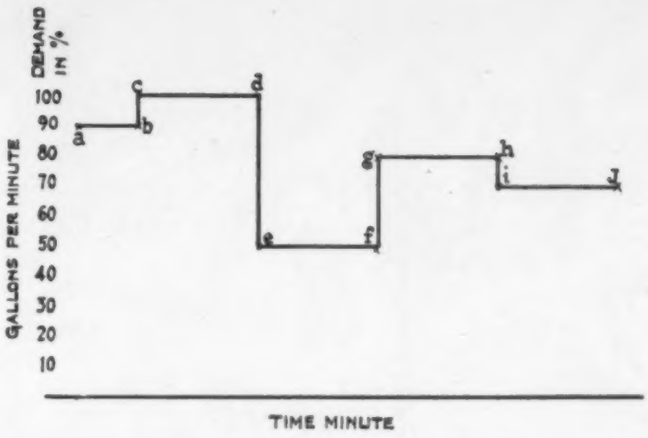


Figure 23 — Maximum demand chart for battery of hydraulic machines.

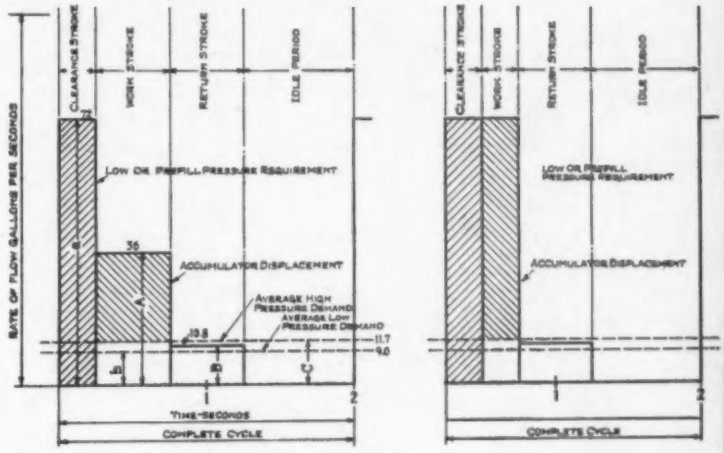
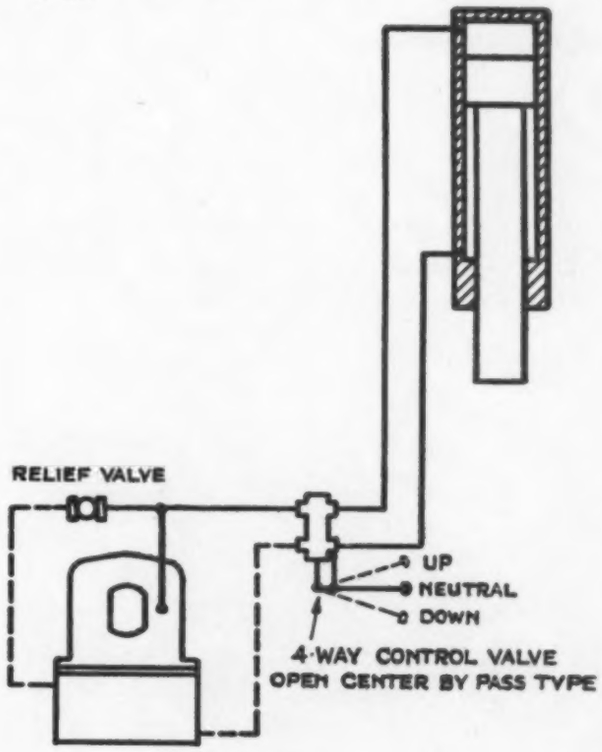


Figure 24 — These demand charts were prepared for a modern high speed forging press.

Figure 25 — This hydraulic circuit is controlled by a 4-way valve.



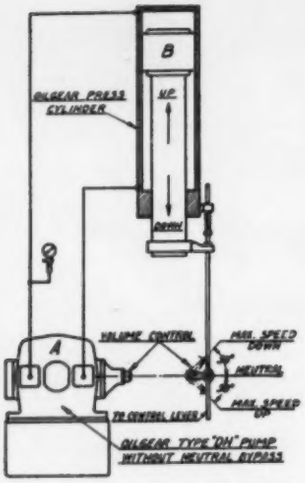


Figure 26 — Control of this hydraulic circuit is obtained with a shifting pump rotor control.

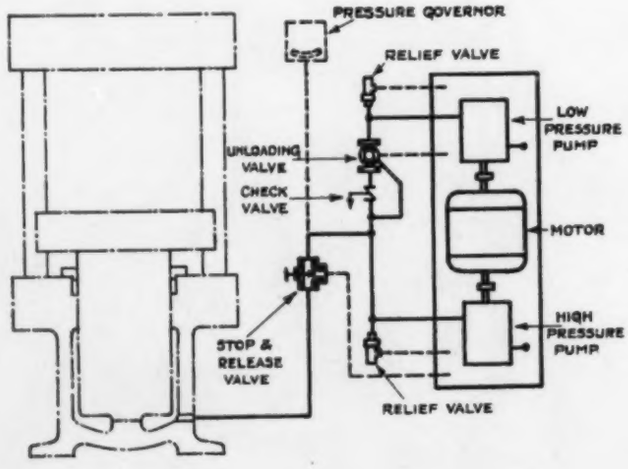
also attendant piping, is of such size as to permit bypassing of pumps and ram return simultaneously. Relief valves are installed to prevent unsafe maximum pressures.

The foregoing describes a small control, using two constant speed, constant capacity pumping units, as for example, systems employing two gear pumps; two constant delivery vane pumps; two reciprocating pumps or two constant capacity rotary piston pumps. The high pressure pump could easily be replaced with a type having suitable maximum pressure control.

For sustained pressure holding uses, this small system, employing two constant capacity pumps, can be used and controlled by means of a differential pressure regulator, often referred to as a pressure governor. For such a condition, a pressure governor is used to stop the pump motor when maximum pressure is reached, and to start again when pressure in the system drops a predetermined amount, usually three to five per cent. Many such controls are in satisfactory operation.

Figure 28 illustrates a filling check or surge system, combined with a single rotary piston type oil pressure pump, having shifting rotor control. This particular circuit is applicable for moderate or high speed service. Short pipe lines connect the pump filling check valve and machine cylinders. Adequate gravity filling of main cylinder during rapid traverse is assured.

Figure 27 — Two pressure, valve controlled, hydraulic circuit.



In operation, the hand lever or foot pedal when depressed, moves pump control to full stroke (maximum down speed) or any fractional portion of full stroke. Oil from pump flows into the top of cylinders D to rapid traverse crosshead downward. Cylinder C is filled by gravity from reservoir through filling check valve B. When the work (and maximum rapid traverse pressure) is reached, the filling check valve automatically closes the gravity line and oil from the pump flows into all three cylinders.

The pressing speed can be varied to suit any required operation and when the present tonnage is reached, the pump stroke and displacement automatically reduces to a point just sufficient to maintain the desired pressure and tonnage continuously. Releasing the control reverses the oil flow from pump and opens surge valve B, permitting oil to be discharged from main cylinder directly back to the overhead reservoir. This permits crosshead to travel upward at maximum speed or any selected slower speed. Operator can stop, slow down or reverse ram movement at will.

This system requires no valve to reverse fluid; reverse of ram is accomplished by the pump control.

While manual operation is shown, semi-automatic and automatic operation can be obtained from a system of this type by proper pressure or electric controls. The diagram shows, as was stated before, an oil circuit employing the rotary piston pump with special control. The use of oil permits use of piston rings for main cylinder plunger packing. However, this basic system is easily applicable to water use by changing cylinder construction properly and by suitable selection of a pumping unit and controls designed for water service. Variations of this basic circuit for both water and oil fluids have been in use for many years. Medium and large size presses usually employ some variation of the system shown if direct pumping is chosen.

Figure 29 shows a machine designed primarily for testing pipe or tubes. After the tube has been placed in position and the ends sealed, the tube is filled with low pressure liquid, usually water, and purged of all air. When the tube has been filled completely, high pressure fluid from the high pressure pumping system, builds up the required pressure.

It is readily understood that the quantity of low pressure fluid will be large in proportion to high pressure fluid. Circumstances usually dictate the selection of a low pressure storage accumulator system with centrifugal pumping equipment, and a direct pumping oil hydraulic high pressure system with variable pressure control. Combining these two systems with an oil-water intensifier, permits obtaining any practical test pressure within the limitations for which the system is designed.

It is also possible to provide a newly developed control, which permits sealing the tube for prefilling with a minimum pressure, just sufficient to prevent leakage at prefill pressure, and have the sealing pressure build up as test pressure builds up inside of tube. Such a control is becoming more and more necessary, as test pressures increase, to prevent crushing of tubes endwise by sealing head force before sufficient resistance pressure is built up inside of tube. Naturally this control was designed for end sealing. Where circle sealing is used, sealing

head force is taken up by proper design of tester frame and tube is not subjected to sealing forces.

The low pressure system should be provided with a constant capacity by-pass orifice, or equivalent, to permit by-passing a small quantity of fluid, to prevent overheating and damage to the centrifugal pump.

The high pressure system need only be provided with a maximum pressure safety relief valve if the three way control valve is of the open center type, that is, a type which permits by-passing the entire pump discharge capacity back to the suction tank at little above zero pressure, during idle periods.

As arranged, the pump pressure control shifts to zero capacity under all normal requirements at the preselected test pressure, the pump by-passes through the control valve during idle periods and the relief valve merely takes care of unforeseen conditions.

Figure 30 illustrates a very interesting application of direct pumping where requirements include both extremely high pressure and large capacity. The machine in question was designed to operate at 6000 psi pressure, 4000 ton capacity. A small weighted accumulator, operating at 1500 psi pressure, furnishes constant pressure for operating pullbacks. Since fluid in pull back system only surges back and forth, a very small pull back system pump is required. This pump need only replace fluid lost through leakage.

Three 317 gpm reciprocating, double acting horizontal, duplex, plunger pumps, operating at 100 rpm, designed for 6000 psi maximum pressure, and provided with 400 hp motors, furnish pressure for the main cylinder. Each pump is provided with a fly wheel to carry 1200 hp maximum load, approximately six seconds. In this case, energy is stored in the fly wheels in place of some other form of storage system. Each pump is also provided with synchronized suction valve unloaders, solenoid operated. Loading and unloading is accomplished by suitably placed limit switches which control unloader solenoids.

With the machine in an open position, operator moves the pilot valve to "up" position. This closes main valve, preventing discharge of any fluid from system back to supply tank. Further movement of pilot valve lever closes normally open pump unloader solenoid circuits, causing pumps to load. Ram moves upward at a speed corresponding to the capacity of the number of pumps in operation, until normally closed limit switch on stationary platen is contacted. This breaks unloader circuits, resulting in zero pump discharge into system.

If operator places pilot valve handle in "down" position, machine "opens." Operator can hold machine in any position by placing pilot valve handle in neutral.

Loading and unloading of all pumps are accomplished in approximately one-quarter to one-half second.

Overtravel of ram, due to time required to unload pumps is approximately one inch maximum, quite sensitive for a unit of this size and far more sensitive than required.

Direct pumping was selected for this application only after all other systems had been carefully studied. It was thought at first that requirements necessitated a rather large air bottle storage accumulator system because of high instantaneous peak demand. By selection of proper size pumps, and equipping same with suitable

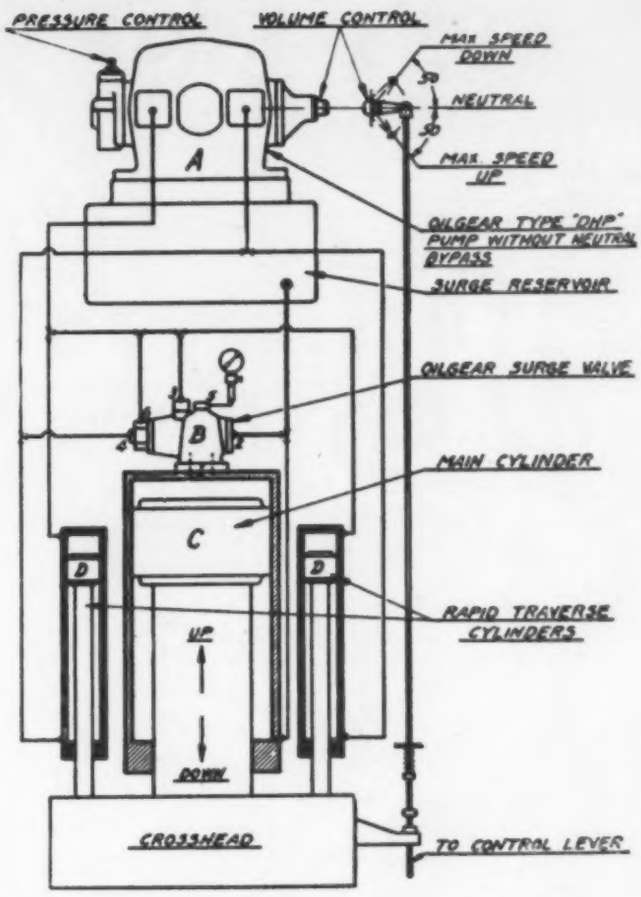
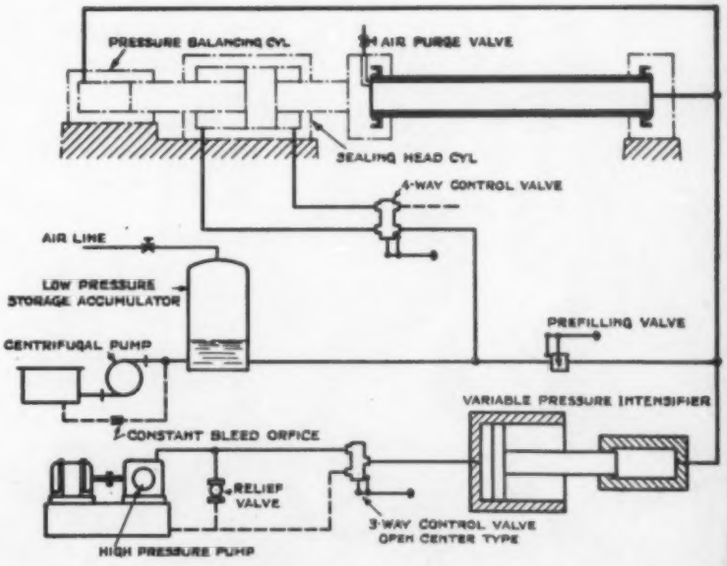


Figure 28 — The prefill system circuit shown is applicable for moderate or high speed service.

fly wheels, required operating speed of main ram could be obtained with motors only about one-third as large as would be required, were the fly wheels omitted.

Figure 31 illustrates a typical storage accumulator system. Only a single pump is shown, but any number

Figure 29 — This machine is designed primarily for testing pipe or tubes.



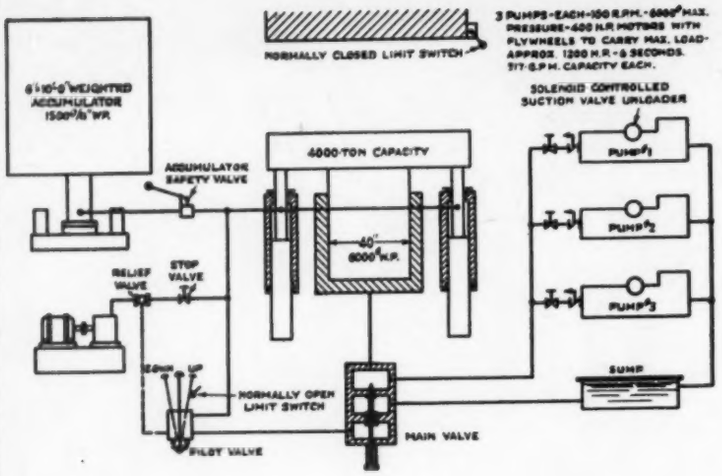


Figure 30 — High pressure, large capacity direct pumping circuit.

of pumps could be installed, depending on the requirements of the system.

Constant speed, constant volume pumps are generally used. When requirements of system are less than pump capacity, accumulator absorbs excess until pump unloading position is reached. Pump remains unloaded until accumulator drops to a predetermined position when pump again becomes loaded. Simple limit switch control of solenoid operated pilot controlled pump bypass valve, (or solenoid operated suction valve unloader), as illustrated, is all that is necessary.

To prevent damage through possible failure of bypass or unloader controls, such as forcing ram out of cylinder of weighted accumulator, a safety switch is shown installed several inches above the "unload" position. If this switch is contacted, pump motors stop automatically.

The accumulator safety valve is a lever operated shut-off valve installed in the discharge line from the accumulator and arranged to close off the flow of fluid gradually in case of excessive demand, line breakage, or for similar cause. A long lever is contacted by the accumulator tank several feet above the bumper blocks. The downward movement of the accumulator tank forces the plunger of the safety valve past holes in the valve sleeve, drilled in such a manner that the flow of fluid is stopped gradually, at the same time gradually stopping the moving mass of ballast and moving parts. Instead of crashing, the tank lands easily and without damage.

Stop valves, to isolate equipment items for easy and quick maintenance, are requirements in all modern systems.

Shock alleviators, of proper size, should be placed in pump discharge lines as well as in the line from the accumulator. The latter, not shown on the drawing, should be placed as near the accumulator as possible and arranged to absorb any inertia shock which might be present.

Speed of movement of accumulator ram is most important. Selection of size of a ram type accumulator depends not only on accumulator displacement required, but also on whether the demand from the accumulator may cause excessive dropping speed with attendant sudden stopping of ram. Excessive ram speed can only result in excessive line shock or water hammer. Many users install fixed orifices in accumulator discharge lines of such size as to limit maximum ram falling speed to safe velocity.

Requirements for a modern air piston type accumulator system are practically the same as for a modern weight loaded accumulator system as Figure 31 graphically shows. Pump controls are similar. No special ram speed control safety valve is required, but to prevent mushrooming end of hydraulic ram and bottom of hydraulic cylinder from contact at excessive speed, a check valve with a maximum ram dropping speed orifice is suggested.

Either system shown is simple. With proper care, maintenance requirements are extremely small. Many

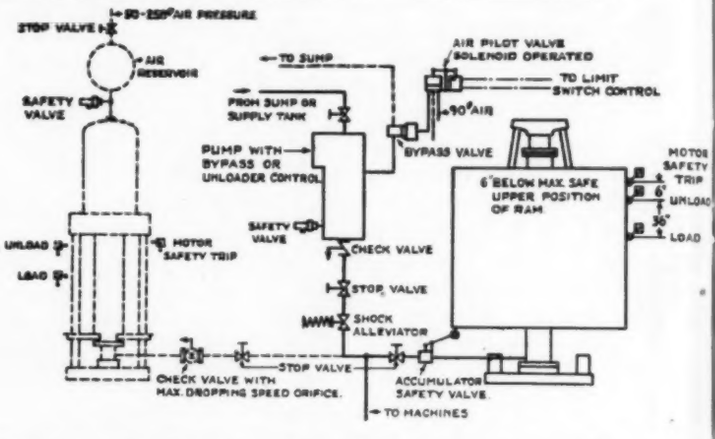


Figure 31 — Constant speed, constant volume pumps are generally used in the accumulator storage system illustrated.

weighted accumulators, in spite of relative deficiencies in design and materials of years ago as compared with modern units, are still giving most satisfactory performance after forty or fifty years service.

For many services, units as just described perform more satisfactorily than those of any other design. Especially in moderate sizes, a modern weight loaded or air piston type accumulator is usually least expensive of available systems for a given set of requirements.

Such units, therefore, should not be neglected when considering any hydraulic system and especially of small or medium capacities.

Figure 32 shows a typical gas loaded bottle type accumulator system. While five bottles are shown, the system could comprise any number, depending on hydraulic displacement required. Multiple bottle systems are usually arranged to have the fluid in only one or two bottles. The other bottles contain only high pressure air

Oil, water, or water containing soluble oil can be used.

If oil is to be used, it is advisable to use an inert gas like nitrogen. For water services, air has been found extremely satisfactory and is used almost exclusively. Nitrogen or other gases are used where hazards of some kind are known to exist.

Air bottle accumulators having displacement capaci-

ties of more than 1000 gallons and operating at 6000 psi are in service.

The advantages of the gas loaded hydraulic accumulator system have been pointed out previously but these advantages only exist if the system is properly installed. For example:

1. Piping must be of ample size and securely anchored.
2. Distribution line velocities should be kept below 20 feet per second to avoid shock, except in very short lines.
3. Distribution lines with dead ends should be avoided.
4. Shock alleviators should be installed to absorb pump and distribution line surges.
5. Charging compressor should be suitable for maximum charging pressure and of ample size.

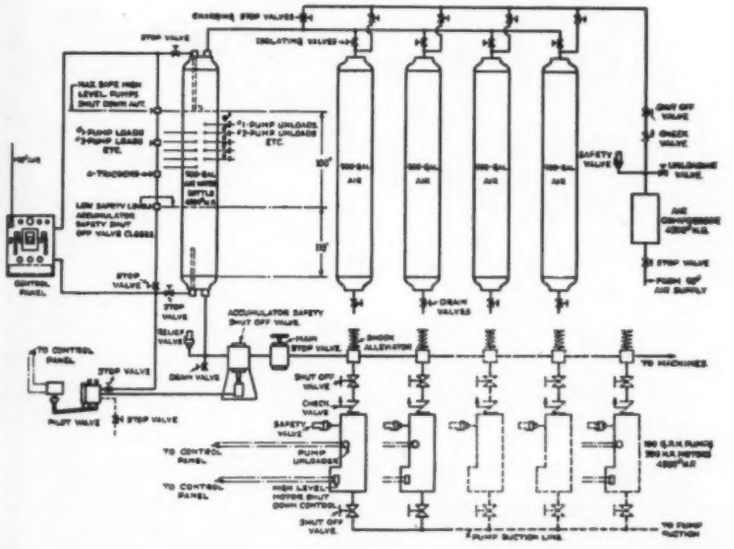


Figure 32 — Multiple bottle hydraulic systems usually have fluid in only one or two bottles.

6. Isolation valves should be installed to isolate any unit of the system for repairs without shutting down or stopping entire system.
7. Any bottle should be so valved as to permit isolation from system, draining, and charging, without interference to balance of system.
8. High safe fluid level and corresponding pressure should be established, and devices installed to prevent damage from excess pressure. A horn, signal light, or gong, to notify the attendant of trouble should be part of this device.
9. Low safe fluid level and corresponding pressure should be established and an automatic shut-off valve installed in the discharge line, to close automatically when fluid drops to this level. A warning signal to call attention of the attendant to the existing condition should also be part of this control.
10. To keep peak power demand as low as possible, pumps should be loaded in sequence with a time interval between successive pump loadings.
11. Pump control, whether by by-pass valve or synchronized unloader, should be selected having characteristics which permit loading and unloading with minimum of shock.
12. Control panel should contain all control, recording and other instruments. Test and operating switches should be conveniently mounted.

Much has been learned about the gas loaded hydraulic accumulator during the last few years. It is no longer a mystery, looked at sideways by engineers.Hundreds of systems, small, medium size, and large, are in service. From these installations, the first ones quite crude, our present knowledge has been gained. The air bottle or gas loaded accumulator is the proper answer for many hydraulic installations, especially in the medium and large capacities.

Figure 33 is a photograph of a complete control for a hydro-pneumatic or gas loaded accumulator system. Since the fluid is stored inside a pressure vessel, often 6 in. or more thick, it is necessary that some kind of a control principle be used, which will transmit from the inside to the outside of the vessel, the story of what is happening to the pressure and liquid level inside the vessel, and include means for controlling same within definite limitations. Two principles have been used:

1. Pressure differential control.
2. Liquid level control.

Figure 33 — Complete control for a hydro-pneumatic, or gas loaded accumulator system.

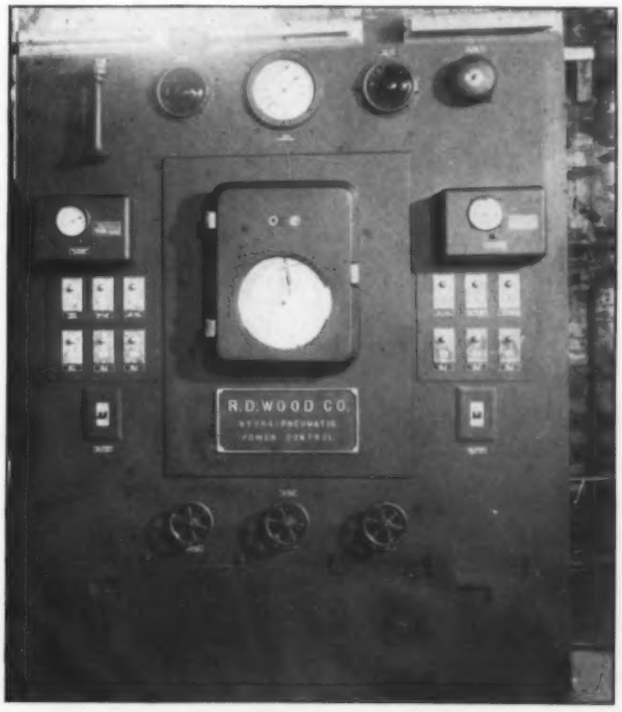


Figure 34 — The panel control shown uses a combination of liquid level and pressure differential control in series for control of high and low safety levels.

Both have been found very successful.

In the pressure differential system, the pressure differential controller energizes and de-energizes various solenoids which control loading and unloading of pumps, the closing of the automatic accumulator safety shut-off valve, and the shutting down of pump motors when maximum high safety level is reached. Liquid level controls are frequently used to accomplish the same purpose.

Experience, however, indicates that a combination of pressure differential and liquid level control is to be preferred. Due to the possibility of any piece of mechanism failing, high and low safety levels should be provided with pressure differential and liquid level control in series. This gives double protection. If either should fail to function, there still remains the other. Whether pump control is by liquid level or pressure differential, under such circumstances, is not so important. Both are obtainable.

The instrument in the center of the control panel, shown in Figure 33, is a ring balance liquid level control and recorder. The ring balance control could be classed as a rotating "U" tube. Rise and fall of fluid in the pressure vessel produces a corresponding rotational movement of the rotating ring. This movement is used for operating as many as fourteen switches and the indicating pointer or recording pen arm. As illustrated, the instrument is provided with three pens and means for recording liquid level in the bottle, pressure in the bottle and temperature of the system fluid.

The value of the record produced by these pens, to the plant attendant, is apparent.

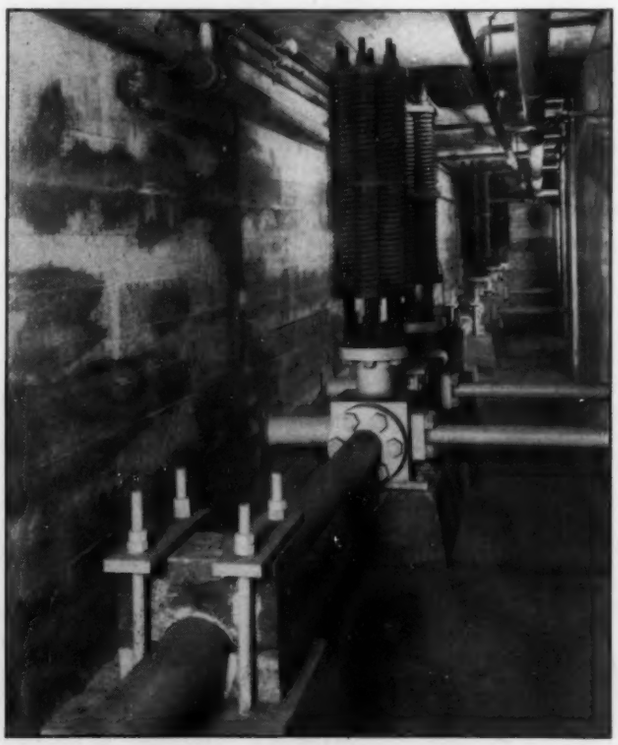
A pressure controller is mounted on each side of the liquid level control instrument. One is connected in series with the high safety level control, and the other in series with the low safety level control of the liquid level control instrument. The indicating system pressure gage, the low level siren, the low level indicating light, the high level signal light and high level signal gong are mounted at the top of the panel. Test switches (for testing safety controls), also pump unloader control switches, are mounted below the pressure controllers, on each side of the board.

The control panel, in Figure 33, is shown arranged for the liquid level control of two pumps. As many as five pump controls, each having different loading and unloading levels can be operated from a single level control instrument, in addition to high and low safety requirements.

This control also offers complete thumbscrew adjustment on all controls. Each control point is adjustable throughout the complete range of the instrument. Cut in and cut out points on pumps can be instantly changed as required. High and low safety levels can also be changed in a matter of seconds, something not to be lost sight of, because operating conditions may change after installation of a system, and there may be errors in assumption made when system was designed, which have to be corrected.

Figure 34 shows a smaller panel control using a combination of liquid level and pressure differential control in series, for control of high and low safety levels. Con-

Figure 35 — The manifold piping shown is for 5 pumps of 300 hp at 4500 psi working pressure.



trol for these three pumps is by pressure differential switches.Panel also includes system pressure gage, low level horn, high level bell, lights and necessary test and control switches.

Panel controls are now sold as complete fabricated units. All the electric wiring is complete to accessible terminal blocks. All hydraulic piping is furnished. It is only necessary for the user to connect the panel board with two lines, one to the air side of the system and one to the water side of the system.

A properly designed, fabricated, and installed, hydro-pneumatic power control, when once properly adjusted, is practically maintenance free. It is only necessary to check the instruments with actual tricock readings infrequently to be sure instrument readings are correct.

The requirements of an orderly and effective hydro-pneumatic-air bottle or gas loaded accumulator system were previously itemized. The following figures illustrate a number of the major points.

Figure 35 shows piping installed in a deep trench, properly anchored, braced, and provided with necessary shock alleviators. This photograph shows the main pump manifold which is supplied by five 300 hp vertical, triplex, single acting, pumps at 4500 psi. Note the brace between the left wall and each shock alleviator. The braces which look like part of the piping, are placed opposite the discharge lines from the pumps, to counteract any horizontal force and thus add to the rigidity already built into the sturdy, and well placed, manifold clamps.

Figure 36 shows main system distribution and return headers in a trench for the same installation. Anchoring of the main (lower) pressure header is most substantial. This 10 inch inside diameter, 4500 psi header was installed with every thought possible being given to installation and maintenance difficulties. This installation permits no excuse for poor maintenance or leaky joints.

Figure 37 shows a combination stop valve and automatic accumulator safety shut-off valve. This valve is mounted just below the discharge nozzle of the accumulator water vessel. The two discharge connections were a necessity as pipe larger than 5 in. cross-section was hard to get for such pressures as 4500 psi. Ordinarily such a valve would be provided with only one outlet stop valve and one outlet connection whose discharge capacity would just about equal the two smaller ones shown.

Figure 38 shows a combination valve for isolating, draining or recharging any one of a pair of bottles. A five bottle system requires two such valves. Each valve contains six spindles, two isolating valve spindles, two drain valve spindles, and two air compressor recharging valve spindles.

Setting between a pair of air bottles, one valve as shown takes the place of twelve individual valves and saves up to thirty or more 4500 psi high pressure air joints per installation, something which needs no further comment. Again one should note how every part is available for installation or maintenance.

Figure 39 is a photograph of the pump room of a modern high pressure hydro-pneumatic (air bottle) accumulator or central storage system, such as was installed in the aluminum, magnesium, steel, and other metal working fields, in great numbers during recent years. The five pumps aggregate 1500 horsepower. (One pump is not shown). The five 900 gallon bottles produce 300 gallons usable accumulator capacity, based on approximately 10 per cent pressure drop. Control is

Figure 36 — The main system distribution and return headers shown are 10 in. inside diameter piping at 4500 psi working pressure.

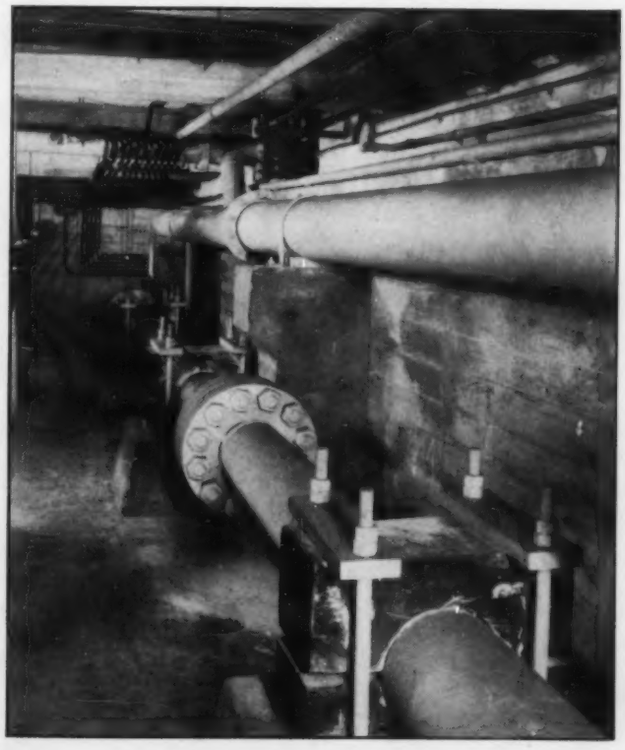
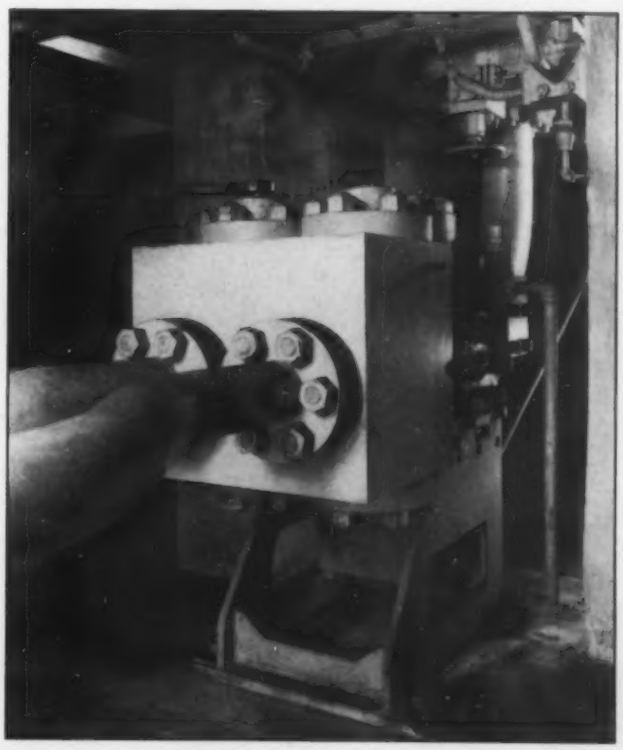


Figure 37 — Hydro-pneumatic accumulator automatic safety shutoff valve with two 5 in. stop valves and two 5 in. discharge lines.



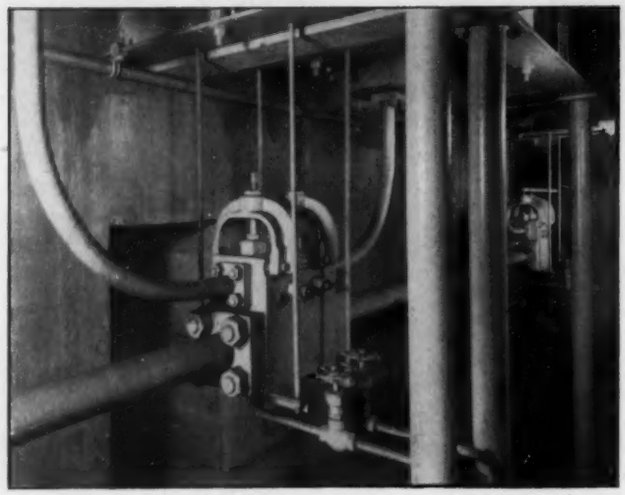


Figure 38 — Illustrated in the photograph is an air bottle isolation, drain and charge valve unit.

by combination liquid level, and pressure differential control panel, shown vaguely in lower right hand corner, is same as previously illustrated.

This and previous photographs show what a modern central storage accumulator can be, when properly designed, manufactured and installed. Such systems require a minimum of maintenance, as war records indicate, and often accomplish certain power requirements better and more economically, than by any other known means. From an installation standpoint, this photograph speaks for itself.

SELECTION OF OIL OR WATER AS HYDRAULIC PRESSURE MEDIUM

Oil, as fluid medium in hydraulic systems, has become more widely used the last decade than in all previous history. Twenty-five years ago, water, or infrequently, water containing some form of lubrication, was almost universally used. The extent of the change might cause the inference that systems still using water are old systems or, possibly, new installation mistakes.

Oil as a hydraulic medium possesses many inherent advantages:

1. It possesses natural lubricating qualities. Since all hydraulic machines have parts which move on each other, the advantages of having automatic lubrication of internal parts with resultant decreased wear and maintenance expense, as a by-product, are not to be overlooked.
2. Corrosion of internal parts of machines and controls is practically eliminated.
3. The oil used may be many times more viscous than water. Therefore, parts do not have to fit so close to still maintain a pressure tight seal. Many machine and control constructions, not suitable for water service, are entirely satisfactory for oil service. Rams, for example, can be fitted with piston rings for satisfactory operation on 2500 psi oil pressure but the same construction would be entirely unsatisfactory on even much lower water pressure.

   Valves and controls can employ lapped pressure fits for oil service permitting perfect balance. Water valves and controls, as now made, are of much more complicated construction and far more expensive.
4. Where lines are exposed and subjected to freezing temperatures, oil has advantages over water. Pipe lines will not freeze up and burst. Valves and instruments will not be ruined. However in severe cold weather, oil becomes viscous and heating means may be required to maintain proper oil viscosity in order that controls will properly function and pump motors not be too severely overloaded.

In general, it can be said that oil operated mechanisms and controls can be manufactured for less cost than equally satisfactory mechanisms which are designed for water operation.

Water on the other hand, practically eliminates the initial cost of fluid. In small systems, this initial fluid cost is negligible, but in systems requiring 10,000 gallons or more, the cost of fluid becomes quite an item.

Water, being less viscous than oil, uses less transmission power. To reduce power consumption and friction loss in a system, larger distribution piping and valving are required, increasing the initial cost of these items.

Some installations practically preclude the use of oil because of the hazard oil creates when under pressure. Presses located close to open heating furnaces and presses located in nonfireproof buildings, are examples of fire hazards which might cause much damage, should a pipe carrying oil under pressure, split or snap at a joint. Water is preferred for most services where fires can be readily started.

All hydraulic machines require distribution piping. This is made up of many sections and units connected together at "joints." These joints are liable to loosen in time. Leakage results.

It is almost impossible to prevent some leakage somewhere around a press system. Water causes less unsightliness over a period of time, around the machine, than oil. This is a minor point but one which should not be forgotten considering the tendency today in most industries is to at least make an effort towards neat, clean, housekeeping.

Where oil contamination of the product to be made on the hydraulic machine would cause rejection of same, water again may have to be used of necessity.

Oil, however, is used in many cases because the press or machine is designed around oil using pumps and constructions, making the use of water impossible. The various pump designs based on principles requiring oil for a hydraulic medium, as described previously, often have sufficient merits which offset any tendencies not to use oil.

To minimize corrosion and to provide lubrication for parts and packings, a small percentage of suitable soluble oil, often called hydraulic oil, is used in practically all water hydraulic systems today. Only old systems, or new systems for descaling or similar uses, still use untreated water.

But again, the final selection, whether it be oil or

water, should be carefully considered and, the larger the system, the more important the selection becomes.

SUMMARY

In the generation, application and use of hydraulic power, there are only a few basic principles. These principles are all simple. Certain hydraulic machines to look at, appear complicated, but in reality the most complicated only consists of a number of sub-units, each a combination of these basic principles, resulting in a simple or more complex hydraulic machine.

Twenty-five to thirty years ago, there were many who forecast the end of hydraulic power for factory and mill use. During the period 1920-1930, it often seemed that these forecasts were about to come true.

But, as in all things, the inherent advantages of hydraulic power, which had been lost sight of in the meantime, began to reappear, when the apparent advantages of other forms of substituted power failed to materialize.

Since 1925 the application and use of hydraulic power has entered a new era of development. All designs of hydraulic machines have been improved. Old ideas have been dusted off and modernized. Speeds have been increased. Presses which formerly made six to ten strokes per minute have given place to units operating much faster. It is possible to obtain presses of 3000 ton capacity, capable of operating at the rate of 50 or more strokes per minute.

The requirements of World War II, have resulted in hydraulic machinery development which should greatly widen postwar markets for such equipment. Many of these developments are already on the market. Others will soon follow.

However, some developments appear certain.

Higher working pressures than the present 2000 to 3000 pound maximum for self contained machines, using direct pumping systems, are already under construction and test.

Simplification of piping and controls will, likely, be a "must."

Standardization of designs of hydraulic presses and machines for various services will be an economic result of market requirements.

Higher press and machine speeds will follow a demand for increased production.

A review of the various uses, principles, generators, systems and circuits previously described, brings out the fact that hydraulic machinery has become precision equipment, built to do precision work. It is no longer "foundry tonnage" built to a market demand to sell for ten cents per pound.

All users have not yet recognized that an extra twenty to thirty per cent original investment cost, permits the manufacturer to build into that investment better materials, better design, better fabrication, which could easily reduce maintenance and operation costs twenty to ninety per cent. The effect of that extra investment on cost of product produced often becomes negligible. For example, a machine which costs $39,000 as against $30,000, would increase the cost of product, assuming 1,800,000 units were produced per year, one-half cent per unit. Based on a product selling price of ten dollars, the increase is one-twentieth of one per cent. It would be a poor improvement which would not absorb this increase many times over in operation or maintenance costs or both.

In the selection or design of any hydraulic system, consideration should be given to items such as:

1. Suitability of the system for the ultimate application.
2. Arrangement, accessibility and location of parts to provide minimum of maintenance cost.
3. Where multiple sub-units are employed, such as more than one pump, etc., can each be isolated from system without undue shutdown and without interfering with continued operation of system?
4. Is equipment substantial enough for the class of work required of it?
5. Are all manual, semi-automatic and automatic controls fully tried, accurate, rugged, dependable?
6. Are safety devices ample and positive in action?
7. Is the design sufficiently versatile for all foreseen conditions?

The omission of a half inch shut-off valve, for isolating some hydraulic valve with a blown packing, may result in a twelve to forty hour shutdown should it be necessary, for example, to blow down and recharge a large air bottle accumulator system. Time has proven to many of us the mistake of trying to get by with a system composed only of bare essentials or one improperly engineered. Any such system will reflect on the designer because unnecessarily high maintenance or production costs are bound to result. Likewise, any such systems, designed and sold by a manufacturer, will reflect on his reputation sooner or later.

Since all hydraulic systems and machines, like all other types of machinery, are subject to wear, especially under severe usage, a good principle to follow in design manufacture selection or use of hydraulic machinery is that the best is none too good

Figure 39 — Pump room of modern hydro-pneumatic accumulator and pumping system.

ROLL OIL EMULSION FOR COLD STRIP ROLLING

. . . . in the past decade, emulsions have been increasingly used as a roll oil in the cold rolling of strip steel . . . . for successful results, oil content must be held between 20 and 30 per cent of the mixture . . . .

By R. W. PIPER
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▲ THE importance of using a good lubricant as a roll oil in cold rolling of strip steel is well known. It is the finding among operating men that the use and application of proper roll lubricants is of utmost importance for good rolling results. For the past thirteen or fourteen years, emulsions have been used increasingly for this important application, replacing such materials as palm oil, light viscosity mineral oil and mineral oil containing additives.

As a basis for discussion of this subject, let us consider a modern four high reversing mill, rolling tin-plate stock using an oil emulsion as a roll oil or roll lubricant. This unit is representative of several such installations in the industry, it being a 42 inch mill having 54 inch diameter backup rolls and 16 inch work rolls; the roll lubricant being supplied from a 5000 gallon capacity central system, which system is equipped with twin basket type strainers, coolers, heaters and circulating pump. The pump has a capacity of some 1800 gallons per minute at 90 pounds pressure with relief valves to provide 40 to 50 pounds maximum pressure at the spray manifolds. The spray manifolds are located at the rolls, and are adjustable for angularity, made of ¾ inch brass pipe nipples flattened to ⅛ inch at the opening.

The roll oil emulsion should be a mixture of 25 per cent oil and 75 per cent water. In the event the oil content goes below 20 per cent, more oil must be added. Should the oil content go over 30 per cent then water must be added. Where the oil content is too low, reduction is difficult, resulting in excessive heat from insufficient lubrication. Too rich a mixture is too heavy in viscosity and can produce the same results as too lean a mixture. In other words, too lean a mixture or too rich a mixture can give the same results, namely excessive heats, too much roll crown, undue screw-down pressures, roll strain, etc.

In cold rolling of strip steel, it is important to make complete use of the coolers and heaters in the roll oil system which have a control range of 90 to 120 degrees Fahrenheit and which under general operating conditions are set for 100 to 110 F. Roll contour is controlled by sprays of roll oil emulsion to the backup rolls. The pressure of the emulsion at the spray manifolds should be definitely controlled as heretofore mentioned, for the reason that improper roll oil pressures can cause heat streaks on the rolls, resulting in unnecessary roll polishing and delays, all of which can be eliminated by proper control of spray nozzle pressures.

Under the described conditions when rolling tin-plate stock using roll oil emulsions exclusively as a roll lubricant, the average reductions and rolling speeds are as follows: beginning with hot roll strip 0.075, No. 1 pass of 39 per cent reduction to 0.046 at 1000 fpm, No. 2 pass of 35 per cent reduction to 0.030 at 1300 fpm, No. 3 pass of 33 per cent reduction to 0.020 at 1500 fpm, No. 4 pass of 30 per cent reduction to 0.014 at 1600 fpm, and No. 5 pass of 29 per cent reduction to 0.010 at 1600 fpm. We all agree that these reductions and speeds are considered good practice for any roll lubricant. Under operating conditions as mentioned, it is usually necessary to add approximately 100 gallons of water to the central system for each hour of operation to replace that lost by evaporation. Very seldom is it necessary to add oil, except of course, the small amount of oil emulsion that is on the hot rolled strip as it enters the mill to be cold rolled. This raw oil emulsion is placed on the strip at the hot mill after pickle and is intended to act as an anti-rust slushing compound or medium for the strip while in transit to the cold mill.

It is always good practice to drain and refill the roll oil emulsion system every six weeks of operation, during which period of time as much as 80,000 gallons of make-up water has been added to the original 4000 gallons required for the initial fill.

The emulsion should be as free as possible from foreign materials, oil or grease. It is important therefore, that maintenance control of mill equipment be strict with the view in mind of protecting roll oil emulsion systems from foreign materials, oil and grease as much as it is possible to do so.

In this connection, most mills are equipped with piston type pumps on the work roll balancer hydraulic system, in which case the roll oil emulsion from the

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central system can be used as a hydraulic medium for this balance hydraulic system, thus eliminating one of the main sources of contamination to the roll oil system when changing work rolls.

Roll oil emulsions have also been used with a great deal of success for the cold rolling of high alloys, silicon, stainless, etc., on somewhat the same type of mill as used for tin plate. However reductions and speeds are not as good as when rolling tin-plate stock. In a few cases, emulsion is used on alloys only for breakdown passes. When using roll oil emulsion on alloys, it is necessary to direct the nozzles or sprays to the rolls only, keeping the same away from the strip as much as possible, in order to allow for some heat build-up in the strip being rolled, this being required to obtain elongation of such alloy strip in rolling. The concentration in the emulsions when rolling alloys, silicons, etc. is much less than when rolling tin plate. Good results are often obtained by using 5 per cent oil and 95 per cent water.

Treatment of water supply used in any emulsion is recommended, and particularly in the rolling of alloys it is necessary. In fact it is a must for good results. The water should be treated the same as would be considered good practice for treatment of boiler feed water. Chlorinated treated water should not be used for making emulsions when rolling alloys containing nickel or chrome as chlorine may form metallic soaps, thus resulting in poor roll life.

In the application of roll oil emulsion for cold strip rolling, it is essential that certain working data be known such as, condition of strip surface to be rolled, analysis of water supply, approximate amount and type of foreign oil or grease present, also cleaning of strip after rolling. The surface condition of the strip to be rolled and the water supply to be used are very important due to the high water evaporation conditions, mention of which was made earlier in this paper.

You will note we speak of emulsions, rather than soluble oils as commonly referred to in industry. Virtually all emulsions used for cold rolling of strip steel use water as a dilute soap solution in the outer phase, in other words, a globule of oil surrounded with water. The suspended substance in the emulsion may be almost any oily material such as sodium, potassium soaps from animal or vegetable fatty acids, naphthenic fatty acids, petroleum sulphonates, etc. The relation of soap to fatty acids is often regarded as a control for a given emulsion. In general, the petroleum sulphonate type of emulsion is best when used as roll oil because of its availability and low cost.

Recently, improved results have been obtained, particularly on high alloys using emulsions made with extreme pressure additives and metal wetting agents; however, complete and definite data is not yet available as it is yet in an experimental stage. Petroleum sulphonate type emulsion is usually made up of 4 to 6 per cent emulsifier, approximately 1 per cent moisture, a small amount of emulsifier passivator, and the remainder a light viscosity mineral oil as a carrier. It is the general consensus of opinion that the value of any emulsion is based on the type of emulsifier used, the light mineral oil being only a carrier for the emulsifier.

Roll oil emulsions should be applied and pressures maintained under the same strict conditions as would apply to any good central lubricating system. After all, the emulsion is the roll lubricant and should be treated as such. The opinion held by some, that is of adding highly oxidized used mineral oil or so-called red engine oil to an emulsion is, in the opinion of lubricating engineers, incorrect. It might be that these additions would help in the case of an emulsion that was made and used immediately; however it has been found to be very important to allow emulsions, after being mixed, to remain dormant for several hours before using in order that the hydrolysis cycle be completed. If the pH value of an emulsion is checked at the time of mixing, then rechecked several hours later, it will be found that this chemical reaction will have taken place. It is good practive to always try to maintain a pH of 7.5 to 9 on any emulsion in the operating system.

In this paper I have endeavored to quote facts and statistics regarding the use of roll oil emulsions in actual working conditions and under sound established practice. I realize that this subject can be treated from various angles of operating conditions and opinions but I trust that the information given herein may be helpful, and in some small way contribute to a better understanding of the subject.

DISCUSSION

PRESENTED BY

W. D. LAMONT, Manager, East Plant, Dominion Foundries and Steel, Ltd., Hamilton, Ontario, Canada

R. W. PIPER, R. W. Piper Company, Pittsburgh, Pennsylvania

PAUL DOYLE, Lubrication Engineer, Corrigan-McKinney Works, Republic Steel Corporation, Cleveland, Ohio

W. D. Lamont: The company I am with also owns single stand reversing mills, similar to the one Mr. Piper mentions. As you all know, the practice on this continent is to use palm oil in tandem mills, and soluble mineral oil in single stand reversing mills. We at our plant have experimented in using palm oil on single stand reversing mills. I was wondering whether you know that you use less screwdown pressure, and you get less load on the motors and why other people are not wanting to do that.

The application of palm oil is difficult. We have tried it by putting the oil on the back-up rolls and by putting it on the strip, and the best method yet devised is to use sprays. One of the difficulties in the single-stand mills is that the oil piles up on reverse, and you get a decrease in your gage.

I should like to ask whether anyone else has done any work along these lines?

We have found at our plant that insoluble oils have many virtues when it comes to working for tons per hour. Our mill operators have found that when their coolant becomes contaminated with heavy lubricant, they can produce more tons per hour. The disadvantage is that it is hard to clean. It just does not come off as readily in the cleaning line.

We at present are experimenting with straight kerosene in the coolant tank, and the couple of days before

I left the plant that it was in use, it seemed to show that it had advantages. The mill operators said the steel seemed to be softer. In other words, it seemed to me that insoluble oils might well be discussed as well as soluble oils.

I might say that to take care of the heavy lubricant that gets into our coolant, which the operators don't seem to mind, we have installed separators which take out that heavy lubricant and keep our coolant in reasonably clean condition.

R. W. Piper: Mr. Lamont, you speak of tonnage. May I inquire what you would consider good tonnage on a 4-high reversing mill, with the palm oil you are using?

W. D. Lamont: We are not using it. We are only experimenting with the idea, as we ran up against difficulties.

Another difficulty we ran into was the fact that palm oil freezes in our water coolers, and builds up around the pipe so you just don't cool efficiently. You obtain a frothing condition sometimes, which you are able to take care of with proper baffles. At the present time we are not using it, but we want to use it. We at this plant get between 50 and 60 short tons in eight hours off each mill.

R. W. Piper: On the mill I have in mind, if you will note the number of passes and the rolling speeds, you will find it is approximately somewhere between 10 and 15 tons per hour or as much as 300 tons in 24 hours operation, using emulsion exclusively and under the mentioned conditions.

In regard to the screw-down pressures, increased power, etc., I feel that is more or less an opinion. I have observed some tests of palm oil versus emulsion and if you use the proper water supply, good emulsion, and sometimes a good wetting agent the power consumption on the mill and the screw-down pressures are about the same on palm oil or emulsion.

If you will take 39 per cent reduction at 1000 fpm on No. 1 pass and increase speed to some 1600 fpm on No. 5 pass, you will find tonnage will be produced at a goodly rate.

Regarding kerosene, there have been several hazardous fires by using kerosene or light mineral oil. You do invite a fire hazard using kerosene or light mineral oil as a roll oil or coolant.

It is often necessary with any emulsion in rolling alloys to use kerosene quite frequently to keep down build-up on rolls, mainly of your metallic soap formations.

Paul Doyle: I would like to ask if Mr. Piper would kindly elaborate a little further on his statement referring to the use of highly oxidized mineral oils.

R. W. Piper: The experience and the theory has been, I can cite five or six such cases, that operators would get excess screwdown pressures, excess reel tension, until they added some red oil, red engine oil, ordinary oil and highly oxidized oil. It was the theory at one plant that the emulsion had to be loaded with lead base grease or some type grease. We believe from the tests that we have observed that the highly oxidized oil, red engine oil, etc., did help on freshly made emulsion. I believe most men familiar with the subject will advise mixing emulsion and not using the same for several hours afterwards as adding oil to water causes an hydrolysis action, which until the cycle is completed changes the final pH value of the emulsion. Too high a pH value, say over 10, causes strip breaking. The same applies to using emulsions for wet drawing steel through dies, too high a pH value of the emulsion may cause breakage. It now appears the general concensus of opinion that adding red engine oil or highly oxidized mineral oil to a roll oil emulsion is detrimental not only to best rolling results but for cleaning as well. All cold rolled strip invariably has to be cleaned, whether it is electroplated or lithographed, etc. Therefore the good cleaning is important for efficient over-all operation.

P. J. Doyle: What do you consider a highly oxidized mineral oil in reference to this case?

R. W. Piper: I would say any oil of 100 second viscosity at 100 F, having a Conradson carbon of over 0.08 or a neutralization number of 0.2 to be in this classification.

P. J. Doyle: It is an answer to the question, but I don't quite agree with you. I have some records here on rolling performance on a four-high, four-stand tandem mill using an oxidized mineral oil with a Conradson carbon residue content considerably above 0.08 per cent and have obtained quite successful results, both from the standpoint of rolling, and cleanliness of the strip at the skin pass mill.

R. W. Piper: Is that the Corrigan-McKinney plant?

P. J. Doyle: Yes, it is and this is what we show as typical rolling performance on our four-high four-stand tandem mill as following: Starting coil 0.072×33 in.

Coil No. A

Stand	1	2	3	4	Reel
Gage	0.0495	0.0254	0.0169	0.0148	
Amperes	1000	1600	2660	1000	600
Fpm	425	830	1250	1425	
Per cent reduction	26.5	48.5	33.4	12.0	
Volts	610	610	610	610	300
Hp	760	1215	2020	760	225
Tension	12000	26000	11000		

Total hp = 5050
Tons per hr = 71.5
Total elongation = 4.72
Hp per hr per net ton per hr per elongation = 14.95

Coil No. B

Stand	1	2	3	4	Reel
Gauge	0535	0239	0168	0148	
Amperes	1000	1700	2300	900	
Fpm	472	1060	1510	1710	645
Tension	12000	25000	11000		645
Per cent reduction	23.6	55	29.7	12.6	
Volts	760	760	760	760	300
Hp	950	1010	2180	852	295

Total hp = 5887
Tons per hr = 86
Total elongation = 4.72
Hp per hr per net ton per elongation = 14.5
Roll finish ..... Bright Bright Bright Blasted

R. W. Piper: Mr. Doyle, your data is very interesting and you are quoting about the same production per mill stand as the figures given in our paper on the reversing unit, considering final gage and tons produced.

MEASUREMENT OF HEATING RATES

IN REHEATING FURNACES

. . . . describing the apparatus and method developed for observing slab temperatures during heating, thus providing definite information and data on actual operation of the reheating furnace . . . .

By J. W. PERCY
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▲ DURING recent years many reheating furnaces of various types have been built and operated, and data relating to fuel consumption, tonnage of steel heated, and over-all performance have been collected. But few data have been available on the actual temperature-time curve of steel slabs or billets as they pass through such furnaces. This information, which is prerequisite to considered improvement in design and operation of furnaces for heating steel, is lacking presumably because of the difficulty of making proper measurements. This difficulty arises from the circumstance that the temperature of the steel must be measured without disturbing the regular operation of the furnace and mill, if for no other reason, because what we need to know is the temperature curve of a typical slab (or billet) during regular operation; yet the results must be accurate within a few degrees if they are to be useful as a guide towards realizing the best furnace design and operating procedure for each type of slab. The several difficulties have been overcome after considerable experimentation, by development of apparatus and methods which have proved satisfactory in practice in the mill; they are now described in this report, and a few typical heating curves are presented and discussed briefly.

We were led to undertake these measurements after careful observations of reheating practice and of the subsequent rolling operation and its product had indicated that the operator does not always succeed in obtaining or maintaining the kind of heating practice which he believes desirable, and that the performance of many furnaces fails to fulfill the expectations of their builders. This situation is unlikely to be improved except on the basis of definite information on the temperature, not of the furnace, but of the steel itself as it passes through the furnace; and this implies that we measure the temperature at the center of the slab rather than merely its apparent surface temperature, which in itself is not necessarily a good index that the mass of steel has been properly heated for rolling. Consequently we developed apparatus and methods which enable us to determine the temperature, both at the geometric center and at the surface of a slab as it passes, as one of a series of entirely similar slabs, through a reheating furnace; and to do this in such a way that the uncertainty in measured temperature is less than ± 5 F. By this means the performance of a furnace under specific conditions of operation such as fuel rate, hourly tonnage, can be assessed from more or less routine observations carried on when desired without interrupting regularity of operation or production.

The measurements were made on each of a series of standard slabs, which ranged in thickness from four to

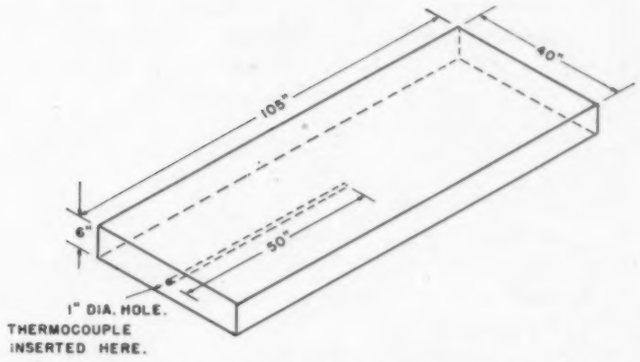


Figure 1 — Holes were drilled in the test slabs so that a thermocouple could be inserted to measure the temperature.

Presented before AISE Annual Convention, Cleveland, Ohio, October 3, 1946.

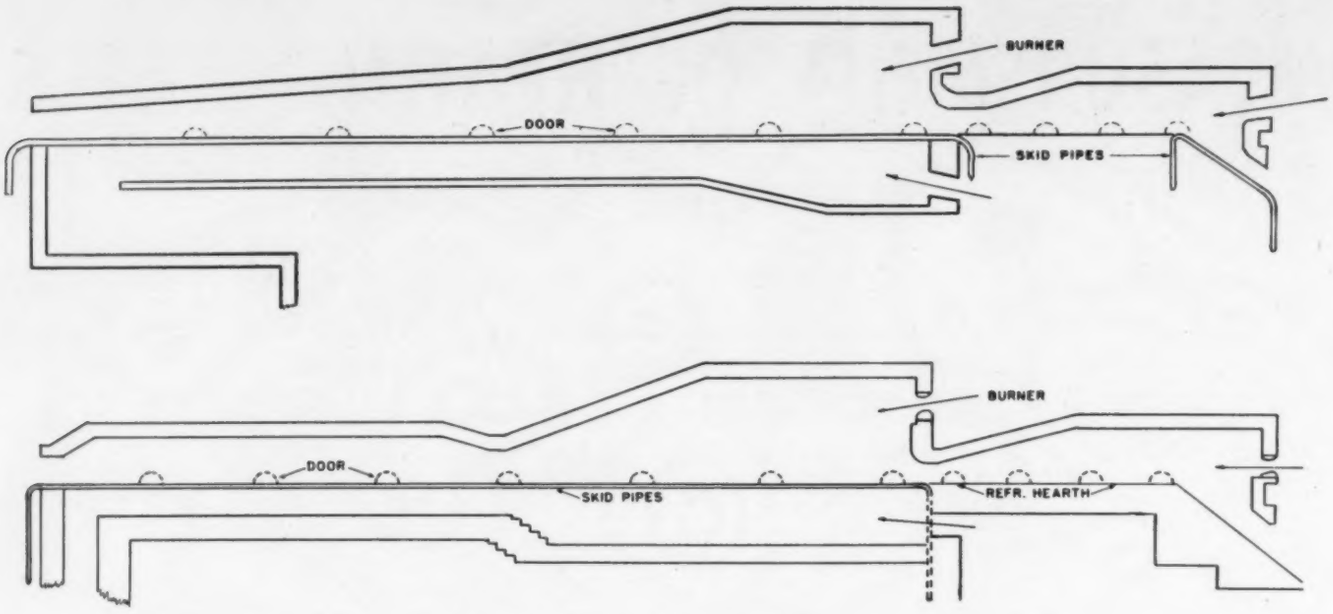


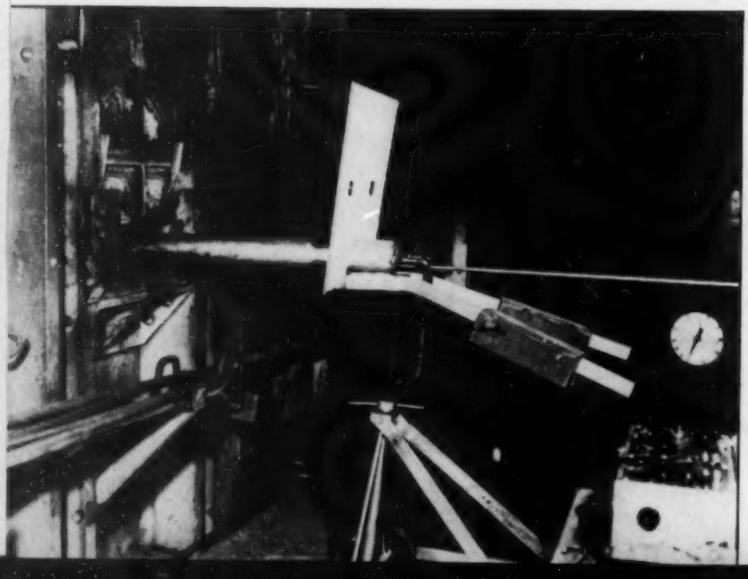
Figure 2 — Furnaces used in tests were typical, top and bottom fired, three-zone furnaces.

more than seven inches. In each test the slab chosen was, as nearly as practicable, of the same size as those adjacent to it in the charge, in order to minimize not only possible differences in heating but also mechanical difficulties in pushing the charge through the furnace. The slab was prepared by drilling a one-inch hole along the major axis to the geometric center, as illustrated in Figure 1. The depth of this hole ranged from thirty to fifty inches, though a lesser depth, not less than three times the thickness of the slab, would probably have given equally satisfactory results. The test slab is charged into the furnace in the ordinary way, the end with the hole for the thermocouple and its protective tube, being near the side wall of the furnace; and it is pushed through along with other similar slabs comprising the regular charge.

The several furnaces in which these series of tests were made are all of the types illustrated in the two elevations sketched in Figure 2. Their construction is generally typical of the top and bottom fired, three-zone furnace built by several manufacturers. The presence of a number of side doors, approximately equidistant along the furnace, made it possible to measure the temperature of the test slab as it passed each door in order to get sufficient data for drawing a satisfactory curve of slab temperature, both at its center and surface, for either distance along the hearth, or time in the furnace.

In making a test, the "push" in the charge is adjusted so that the test slab is in front of each side door long enough to permit the measurements to be made with the equipment as now developed. These measurements require not more than two minutes, and consequently cause no delay even when the mill is operating at a high rate. The procedure is not difficult, though the flame and heat issuing from the open door make it somewhat uncomfortable for the operator. To aid and protect him, a mobile water jacket, about four feet long equipped with a shield, is mounted on a special two-wheeled carriage, illustrated in Figure 3; this carriage is made so that it is readily disassembled for easy transportation or shipment.

Figure 3 — A mobile waterjacket and shield were built to aid the operator in inserting the thermocouple.



The temperature at the center of the slab is measured by means of a platinum platinum-rhodium thermocouple, about 10 feet long, enclosed in a protective tube, $\frac{3}{8}$ inch diameter, of stainless steel, from which it is insulated by ceramic beads. The tip, or hot junction, of the thermocouple, is covered by a silica tube, closed at one end, which has been cemented into a piece of $\frac{1}{2}$ inch stainless tubing, but partly cut away along the sides opposite the junction as illustrated in Figure 4. This assembly is made fast to the long protective tube, and the thermocouple is then ready for use. By this design, which is patented, the thermocouple is kept away from the harmful action of the hot furnace gases, and the silica tube insulator at its tip is protected from mechanical shock or damage; yet it permits rapid transfer of heat to the hot junction so that exposure for half a minute suffices to equalize the temperature and give consistent readings.

Rapid measurement of the surface temperature was

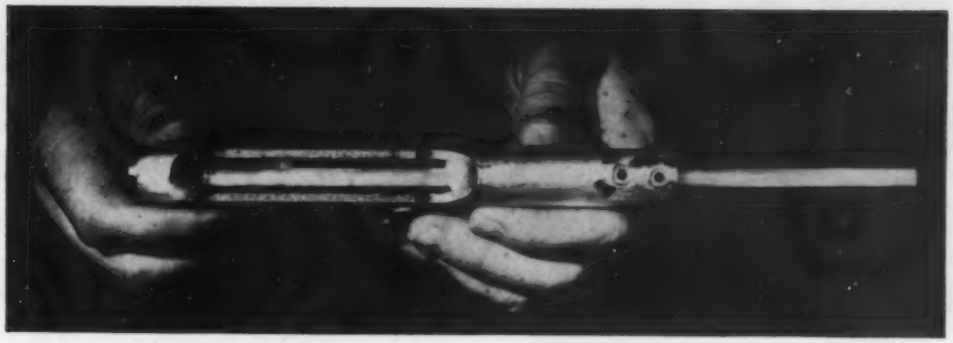


Figure 4 — A protective tube which permitted rapid transfer of heat to the hot junction was used to protect the thermocouple.

made possible by development of a special patented type of surface pyrometer, one form of which is shown in Figure 5. It comprises essentially a radiation unit housed in a water-jacket attached to a tubular handle, ten or twelve feet long, through which pass the electrical connections and the water lines. This unit is used preferably in conjunction with a high speed recording potentiometer, which greatly lessens the chance of error, and requires an exposure of only 10-15 seconds for a satisfactory rading of surface temperature. This pyrometer with appropriate lagging or ceramic covering weighs about 50 pounds, and can readily be manipulated by one man. With sufficient water circulation it can be held in the furnace for as long as a minute without damage to the radiation unit. With it, consistent readings of temperature can be made at any point which is accessible on the upper surface of a slab or billet, or strip while in the furnace.

With this special equipment, measurement of both the surface and center temperature of a test slab or billet during its passage through the furnace, as one unit in a charge of similar slabs or billets, is simple. The test piece is "spotted" when opposite each door consecutively, the mobile water jacket and shield are brought into position in front of the door, and the protective tube of the long thermocouple is pushed to the bottom of the hole in the test piece. The thermocouple is left in position for exactly 30 seconds, and its electromotive force then read on a semi-precision type potentiometer. The thermocouple is then withdrawn, and the water-jacket is moved out of the way. The surface pyrometer is pushed across the slab surface on its three feet, located over the bottom end of the drilled hole, left in that position for about ten seconds until the temperature is recorded, and then withdrawn. The total elapsed time for both determinations is less than two minutes, almost never enough to affect the usual operating rate of the furnace.

The procedure outlined above has been followed in measuring both center and surface temperatures of a slab as it passes through the furnace; several thicknesses of a slab were tested in several furnaces, and at different times in the same furnace. In general, the test was made when the heating operation was proceeding regularly and normally; but owing to unavoidable irregularities in operation, due to factors such as mill delays, successive runs on the same slab in a single furnace follow, not a single curve, but one of a group of similar curves all lying within a band or envelope. For instance, Figure 6 presents a pair of typical curves (one drawn solid, the other broken) of both surface and center temperature of the same slab in the same furnace plotted against: (a) elapsed time in furnace; (b) distance along the hearth. It will be noted that there is a nearly constant temperature difference between surface and center until the slab is about two-thirds of the way through the furnace, that is, entering the "soaking" zone, when it passes through zero and reverses, this reversal being due largely to a considerable (150 F) drop in surface temperature while the slab remains in that zone. This raises a question as to the desirability, or economy, of this final drop of temperature, or of a distribution of temperature in which a slab ready for

Figure 5 — A special surface pyrometer was designed for these tests.

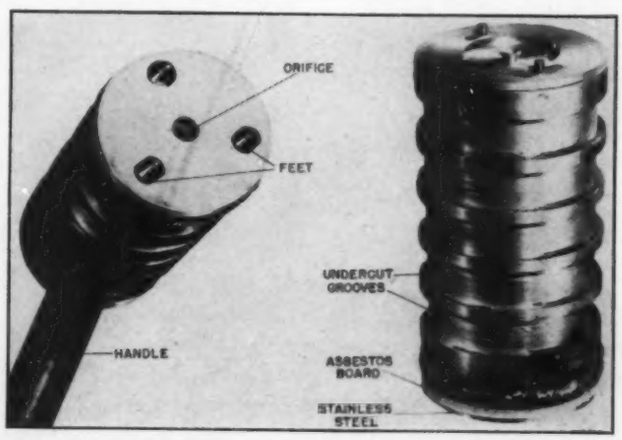
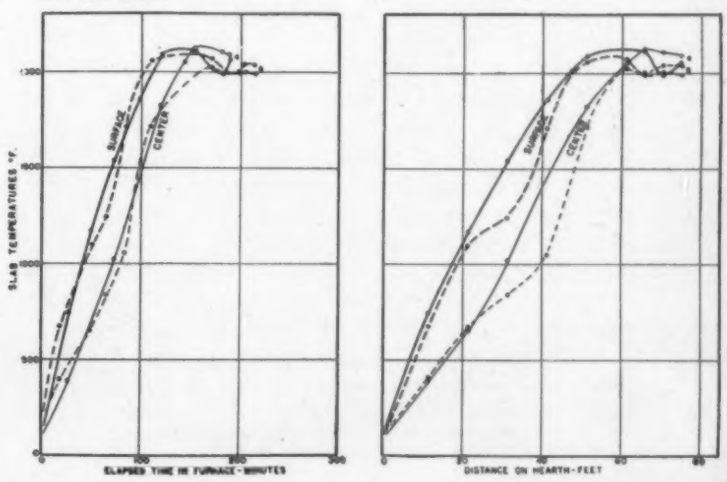


Figure 6 — Surface and center temperatures of 7½ x 30 x 211 in. slab.



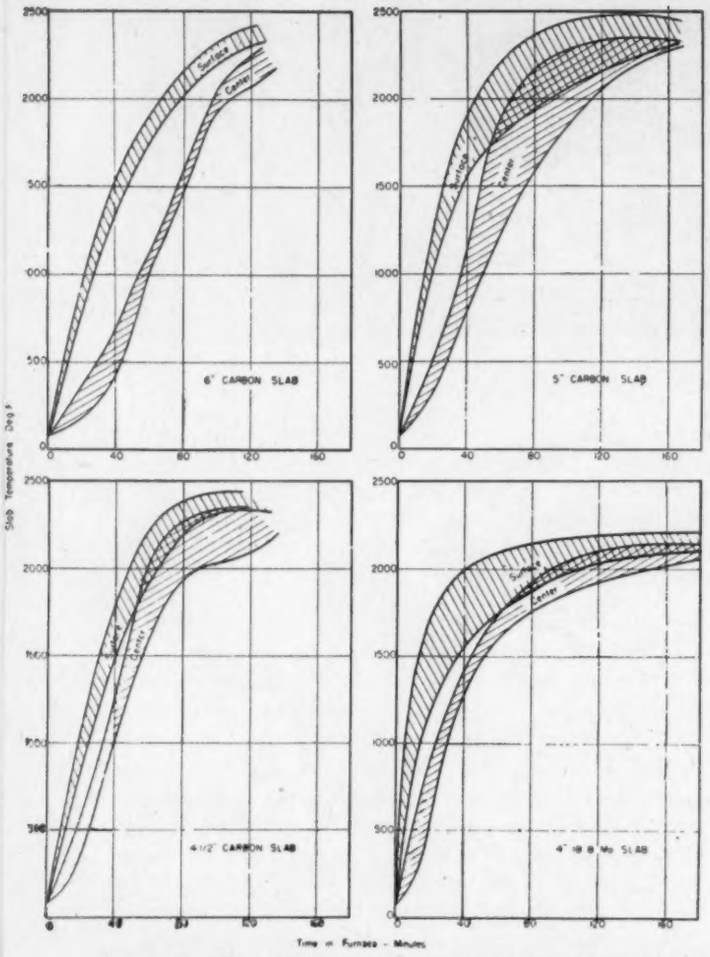


Figure 7 — The surface and center temperature of slabs during heating may be contained in a series of envelope curves.

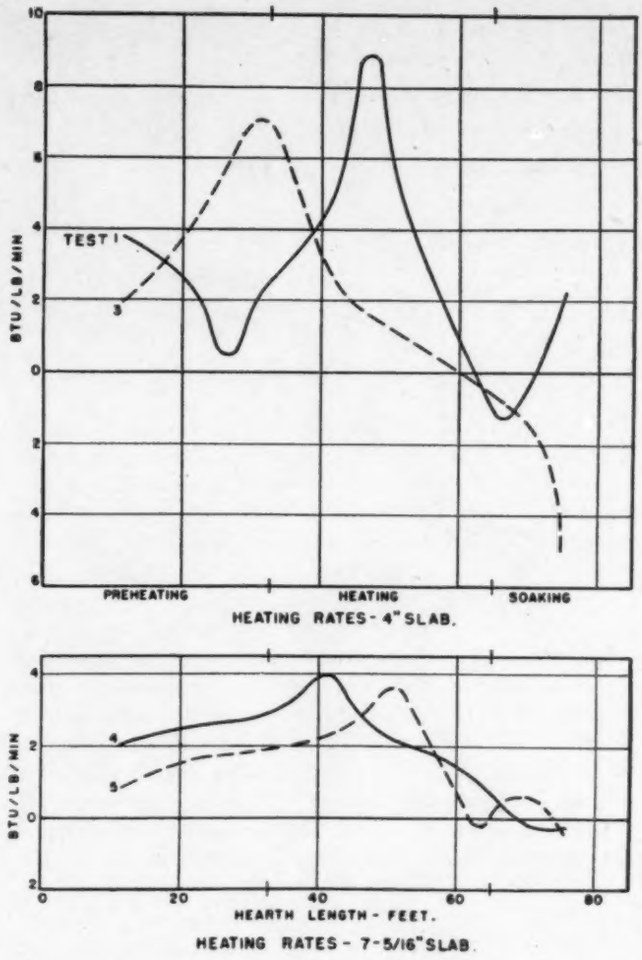
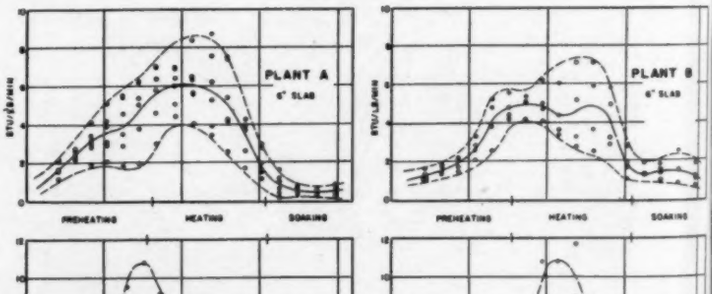


Figure 8 — In the soaking zone, there may be even heat output from the slab.

▲

Figure 9 — The solid lines show the mean heating rates, and the broken lines show the observed maximum and minimum heating rates derived from the center temperatures of low carbon steel slabs.



rolling is decidedly hotter at its center than at its surface.

A series of envelope curves, derived from many measurements for slabs of different thickness in different furnaces, are reproduced in Figure 7, the individual points being omitted for the sake of clarity. They represent the maximum and minimum rates of heating actually observed, and illustrate the differences which occur in ordinary practice from one slab to another, also between surface and center of any one slab. For instance, in a 5 in. slab this difference may be as much as 800 F after 80 minutes in the furnace; and on a 4½ in. slab, 300 F after 110 minutes.

These temperature-time curves are readily transformed* to very similar curves for heat content (Btu) per pound of steel against time in the furnace. The tangent to this curve at any point is the rate of heat input at that time, in Btu per pound per minute. If now the value of this tangent at a number of points is plotted against the corresponding position in the furnace, we get a curve such as those drawn in Figure 8. Here the solid curve refers to one test, the broken curve to another, in the same furnace. These typical curves show that the rate of heat input to the steel (in this type of furnace) rises to a maximum well along the hearth, from which it drops rapidly to zero or even to a negative quantity (i.e. heat output) as the slab enters the so-called soaking zone; and that the maximum rate of heat input per pound steel to the 7 in. slab is not quite half as great as to the 4 in. slab.

If, as basis for this type of curve, we use the envelope

*The heat content data for this conversion are substantially those given by AUSTIN, *Ind. Eng. Chem. 24*, p. 1225, 1932.

curves (as in Figure 7), we obtain the maximum, minimum and mean heat input curves in Figure 9, as derived from measurements on 6 in. slabs in two mills, and on 5 in. and 4½ in. slabs. There are obviously quite considerable variations in practice. even on slabs of the same thickness, and the maximum practicable rate of heat input seems to be approached less often than it might be. Our present picture of the most desirable practice, for heating carbon steel, is that the rate should be greatest near the charging end while the slab is still cool and can absorb heat rapidly, and that the rate should then taper off to almost zero, possibly with a slight increase towards the end of the cycle, which would allow the temperature to equalize through the slab just before it leaves the furnace. Establishment of this optimum must await further work.

The apparatus and method, which have been described and illustrated above, can be used immediately as a definite basis of judgment (as opposed to mere opinion) with respect to the best mode of operation of a given furnace and for assessing the effect of factors, such as delays, on the heating of steel. This use can readily be extended to provide definite information on the relative advantage of differences in design of furnace, in burners or arrangements of burners, in type or rate of fuel supply, etc., as a means of heating steel properly; and thus serve as a sure guide towards more efficient heating and greater over-all economy.

DISCUSSION

PRESENTED BY

E. C. McDONALD, Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio

J. W. PERCY, United States Steel Corporation of Delaware, Research Laboratory, Kearny, New Jersey

G. R. McDERMOTT, Vice President, Surface Combustion Division, General Properties Company, Inc., Toledo, Ohio

W. TRINKS, Associated Engineers, Pittsburgh, Pennsylvania

ALAN SALKELD, Steel Processing Company, Pittsburgh, Pennsylvania

FRED S. BLOOM, Bloom Engineering Company, Pittsburgh, Pennsylvania

H. H. DINNEEN, Rust Furnace Company, Pittsburgh, Pennsylvania

E. A. VIEROW, Superintendent, Fuel Department, The Youngstown Sheet and Tube Company, Youngstown, Ohio

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

J. D. KELLER, Consulting Engineer, Pittsburgh, Pennsylvania

VICTOR PASCHKIS, Technical Director, Department of Mechanical Engineering, Columbia University, New York, New York

E. C. McDonald: From your experience with these tests do you think additional tonnage can be obtained from a furnace by using a thicker slab?

J. W. Percy: I would say not in total tonnage. You may gain a little bit because of the thinness of the smaller slab. It does heat faster, but I think total tonnage is the answer.

G. R. McDermott: I would like to ask the author if he has translated his results, which are very interesting, in terms of pounds of steel per square foot of total hearth covered and also pounds of steel per square foot of soaking hearth covered? Are such data a constant or a variable, depending on to what the finished product of the mill is going to be applied?

J. W. Percy: I have translated many of these data into the units you mention. As far as I am concerned, the results vary quite a bit, seemingly dependent upon the thickness of the slab, rate of heating, type of combustion, and perhaps to some extent upon the contour of the roof. It is a very difficult matter to arrive at the real capacity of any furnace.

W. Trinks: I would like to ask Mr. Percy why he selected 50 inches of depth for the holes. I will give you my reasoning, why I think that 25 in. would have been better. As a rule, the temperature is not constant over the width of the slab. The temperature may be higher in the center than at the ends or the other way around. In either case, the average temperature is at 25, not at 50 in. Why did you select 50 in.?

J. W. Percy: I selected 50 in. in that particular case, because it was approximately half of 105 inches long.

W. Trinks: But 25 in. would be better.

J. W. Percy: The only reason I used a depth such as 50 inches was that I wanted sufficient depth to get away from end effect; that is all I was worried about. There may be much merit in your reasoning. I hadn't thought of it from that viewpoint at all.

W. Trinks: I have another question. Did you each time, before you used the radiation pyrometer, scrape off the scale carefully? These figures which you have in the illustration seem to indicate that you did not.

J. W. Percy: I did not scrape off the scale to any extent. You appreciate probably the difficulty of trying to scrape the scale off a piece in a furnace that is operating around 2350 degrees. I have not found a good way of doing it.

W. Trinks: From all observations which I have made, there is very often a temperature drop from the outer surface of the scale in the steel of 300 or 350 degrees, and particularly near the ends of the heating zone.

That would mean that the surface temperature appears too high. I cannot imagine that, as we heat the steel, the difference of temperature between the outside and the inside remains constant. As soon as the steel enters into the soaking zone, where a lower temperature prevails, heat is not driven into the scale. Hence, we immediately get a very much lower surface temperature of the scale, although the temperature of the steel does not change.

J. W. Percy: You are absolutely correct. I did not

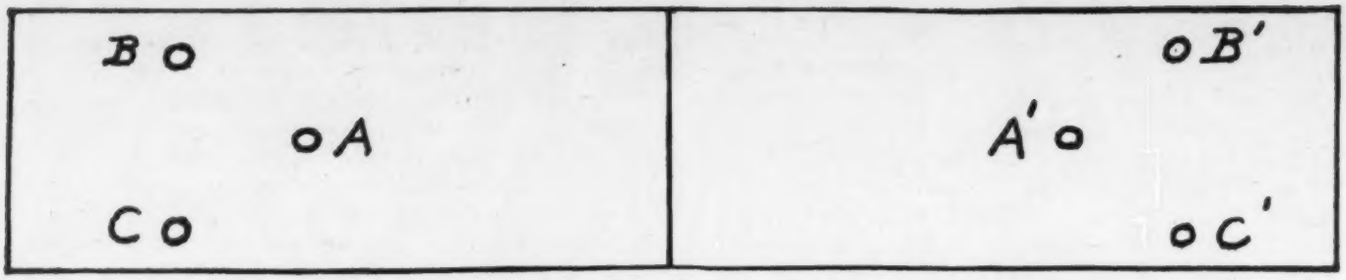


Figure 10 — This sketch illustrates standard method for measuring slab temperature.

intend to bring that in here, but since you have, I will tell you about some calculations I made on some of the data you have seen this afternoon.

I took some of these same data, made some calculations and found out that working from the inside or the center temperature toward the surface, and calculating the surface temperature, a differential in temperature in a quarter inch of scale amounts to something a little less than 200 degrees, and I think that is correct. I haven't found a good way of getting rid of that scale. In fact, I haven't found any way of getting rid of it. I would like very much to take the true surface temperature, but haven't been able to do it.

W. Trinks: The standard method of measuring temperature, as far as I know, is this, see Figure 10. We make a center hole A; we make another hole B; and we make another hole C. B and C are as close to the surface as we can get. Of course, the holes are out of line, but in the next slab we reverse that. We make holes A′, B′, C′ and then we have a curve which we can extrapolate to the surface. I think that would be better. That can be extended to the bottom for measuring the bottom temperature, which you now cannot do. Since on these furnaces which you showed, we also bring in heat from the bottom, it may be more important to know what the bottom temperature is, than to determine top temperature.

J. W. Percy: The suggestion is excellent. As a matter of fact, I have used exactly that same scheme, but not in this type of furnace, for it is very difficult, especially in these long furnaces. The whole job is pretty difficult, as a matter of fact. It is quite a job to drill a one-inch hole in these slabs.

W. Trinks: It would not be with 25 inches depth.

J. W. Percy: If you drill two or three holes in a slab like that, you have cut out so much metal you haven't very much left. I wonder how that will interfere with your results.

W. Trinks: Perhaps if you make the hole not so deep, you can use a smaller diameter. This has been done.

J. W. Percy: That would be possible, but it is very difficult to hollow-bore a hole less than an inch in diameter. I fully realize the part that scale plays in such measurements but I doubt if in these measurements the differential is ever more than 25 degrees or so, certainly not of the order of 200 for then we would find the real surface temperature less than the center temperature well up in the heating cycle which doesn't seem possible.

G. R. McDermott: I would like to know if Professor Trinks is familiar with the European strip mill furnaces where a vortex throat is used to correct the condition existing in the soaking zone mentioned in the paper. The European furnace has a particular construction of the throat between the soaking zone and the main heating zone. The purpose of the throat is to create a positive pressure in the soaking zone by means of the combustion gases passing from the soaking zone to the main heating zone. Could you give us some enlightenment on that feature of design?

W. Trinks: I did not look into the furnace for that feature. I simply was told that it had a very beneficial effect. We didn't go into details. Mr. Percy, in his last words, spoke about more efficient heating. There are two types of efficiency. One of them is fuel efficiency, and the other one is getting all you can out of the furnace. The two are opposed to each other. If we talk about fuel efficiency, then we must put in a great deal of heat near the hot end of the furnace, but if we want capacity, then we must put in as much heat as the steel will absorb at the cold end of the furnace.

The forge people in the heating of 8 × 8 or 9 × 9, or even 9½ × 9½ in. billets for shells use the principle of getting all they could out of the furnaces, by side firing. And they fired as hard as they could from the very beginning, and then afterwards they tapered the heat down toward the hot end. The steel man in slab heating does just the opposite. He fires all he can at the hot end and says the cold end will take care of itself. To my mind, it would be much better to side fire, and fire quickly all you can, and then put a recuperator on after that.

Alan Salkeld: With all due respect to my colleague, the Professor, I think he will remember that in the fastest producing shell plant in the United States and Canada, the heating was done at the exit end. They produced more shells per hour than any other plant produced in two hours.

W. Trinks: As I remember it they had a short furnace and fired so hard that the gases were still very hot when the steel entered.

Alan Salkeld: The furnace was about 58 feet long. The billets would run up, for 105 millimeter shells, to about 5 inch, round-cornered squares.

Fred S. Bloom: I would suggest that the Association of Iron and Steel Engineers, at some later date have a symposium prepared, using these curves, because they give us a large amount of information. I have been fortunate in having a number of similar curves for study, which Mr. Percy has made, and they do present

I marvelous picture of what goes on in the heating furnace.

Before we go into questions and answers, I think we should all realize the amount of time and the amount of money the United States Steel Corporation has spent to give us this information, and the amount of time that Mr. Percy has personally devoted over a period of six to ten years to collect this information. a think the U. S. Steel Corporation should be thanked for their generous attitude in letting this group of men observe results which have probably cost them $100,000 to determine.

There are one or two items that I cannot pass over. I had the question of scale resistance. We all know that it amounts to something. How much it amounts to, I don't know. In the early part of the test it probably doesn't amount to very much. In the final heating, where we have a fairly heavy scale, the difference in temperature between the inside scale surface and the outside scale surface may be 150 degrees or it may be 250 degrees. If it is true that our outside surface scale temperature is 150 degrees hotter than the actual steel surface, so much the better, because we are doing a better heating job and our steel surface temperature is closer to our center temperature, and our soaking time can be greatly reduced, or in some cases eliminated. If you take 150 degrees off the surface temperature at the top of the heating curve, our center temperature curve is then very close to our new surface temperature.

There is one question I was trying to get clear when I studied Mr. Percy's data. I don't know how he arrives at his figures. He takes some temperature as a basis in making these heat calculations for the Btu rise per pound per minute. Does he take center temperature, does he take surface temperature, the mean between, or what does he take?

In other words, if he takes center temperature, then the heat absorption curve is what he has actually calculated. He calculated Btu per pound per minute, and he said in part of his paper that a 7 inch slab gets more heat, Btu per pound, than does a 4 inch slab. But if you take pounds per square foot of slab surface, then the Btu absorbed comes out very close to the same figure. So it is all right. You can interpolate it. If you study these curves, there is an immense amount of information which can be used as a basis for a better furnace design.

The other thing I would like to ask Mr. Percy is the effect of the water-cooled pipes. I know he has some information on this. What is the difference in temperature between the steel on the water-cooled pipe and the steel in the middle, that is, in between the water-cooled pipe? It has much to do with how we design the furnaces. The furnace builder would like to know, for it affects somewhat the heating rate.

The other question deals with the curve of Figure 8. What is the broken-line curve? You have a straight line in Figure 8, and then you have a broken line. What does the broken-line mean?

The information is quite conclusive, for to me, Mr. Percy has presented a picture which, though it may not be 100 per cent correct, does show the trend. If we study heat absorption to steel, as applied to position in the furnace, we get a curve which shows where the furnace delivers the heat to the steel.

The heat absorption curve, Figure 9, shows that 75 per cent of the total heat needed in the steel is delivered in the first 50 per cent of the furnace. The last half of the furnace in some cases, lets the steel drop in temperature, and in some cases, center temperature is higher than surface temperature. This condition of steel heating needs more study, for I believe it is the cause of many of our steel and furnace problems. It often happens that steel half the way through the furnace is ready to roll.

I cannot agree with Professor Trinks, who has advocated increasing the heating capacity by increasing the heating rate at the charging end. It is true that we can increase the heating rate here without hurting the steel, but the percentage increase will be small and the fuel efficiency greatly decreased. Why don't we give some thought to increasing our heating rate in the last 50 per cent of the furnace? In most cases, 100 F higher flame temperature will double the heating rate in the last 50 per cent of furnace length, and thus increase the total furnace capacity by 25 per cent.

W. Trinks: Mr. Bloom, I did that in one furnace and I doubled the capacity.

Fred S. Bloom: In the back end of the furnace?

W. Trinks: I put heat in the back end and center of the furnace and it doubled the capacity of the furnace.

Fred S. Bloom: That doesn't mean too much to me. How good was the furnace when you started?

W. Trinks: It wasn't as good as it should have been.

Fred S. Bloom: Right! I don't think the engineers here should be misled because this is a very critical factor. The thing we have to worry about is that there is a definite relationship between the temperature you can arrive at in the main heating zone of a three-zone fired furnace and the back end or waste gas temperature. Design the roof one way, and you get one thing; design the roof another way and you get another thing. We now get a heat absorption rate under 20,000 Btu per square foot of steel surface at the charging end and we have a temperature of about 1600 F discharge. If we raise this temperature to 2000 F we will get up to a heating rate of about 35,000 Btu per square foot. We can accomplish it; I have no question about it. But if we accomplish it by decreasing the temperature in the main heating zone, we may lose more than we gain. There are too many furnaces today which are too hot at the charging end and not hot enough at the discharging end.

So I am taking the opposite side. I know I am, but we have some experiences on furnaces which were designed to heat steel continuously through the furnace. That is, keep the steel increasing in temperature. Stainless steel heating must be done this way and still we have very few furnace designs which will let us establish this heat pattern. Our experience indicates that there is nothing worse than to have steel ready to roll when half way through the furnace and then try to hold the steel at elevated temperatures for the remaining 30 to 60 minutes.

A uniform temperature rise heating rate curve is the ideal method of heating for quality of product and fuel

efficiency. This means a heat absorption rate of approximately 40,000 Btu per square foot of steel surface per hour for a furnace rate of 100 lb per square foot per hour and heating from one side. This is possible on steel 4 in. or under, but for thicker steel 40,000 Btu per square foot per hour is too fast for steel at temperatures over 2000 F. In most cases, nature takes care of itself because you will find it almost impossible in any furnace today to get heat absorption rates over 25,000 Btu per square foot per hour with steel surface temperature over 2000 F.

The object I am trying to bring out is that, as furnace engineers, we will make a mistake if we try to increase our furnace capacity by a further increase in the heat now put in the steel at the charging end. A careful analysis of Mr. Percy's data will show that about 75 per cent of the total heat goes into the steel in the first 50 per cent of the furnace so how can we improve by raising this percentage to 85 per cent for the first half and thus lower the remainder to 15 per cent. That does not make sense to me. He can increase the total heat input by elevating all temperatures, but please don't change the ratios.

J. W. Percy: In answer to your first question, regarding the temperature basis for these calculations, the ones that you saw on the board were all based on the center temperature. I neglected to say that, and I am glad you brought that out.

Fred S. Bloom: In other words, you can move your heat absorption curve back further towards the charging end of the furnace. That is, you have not accounted for the time lag of center temperature behind surface temperature.

J. W. Percy: That is right. I have used that same scheme on both the surface and center temperatures, but the shape of the curve was essentially the same.

Fred S. Bloom: What did you do when you went through your critical temperature? You don't show any slowing up of temperature rise. You don't show that 20 Btu per pound you are bound to put in there. How did they throw it out?

J. W. Percy: In these particular curves, the critical point is not so apparent; in others there is some slight indication of it.

Fred S. Bloom: You have to take your heat content of the steel as you go up in temperature to calculate your heating curve so the 20 Btu rise at the transformation point should show up in your curve. How do you get through that point?

J. W. Percy: You must remember that these curves are based on about 10 points, and it is possible that one of these transfer points occurred between the doors. That is the only way I can explain it. These curves are smoothed out. They do not represent perfect curves. They are based on 9 or 10 points, depending on the number of doors in the furnace. I have examined a large number of these curves, and I have, with few exceptions, been able to find an indication of the transformation point.

In regard to the temperature over the skid pipes, I mentioned the one occasion when we ran into difficulty on that account, and I think, if my memory serves me correctly, we found a decrease in temperature of something on the order of 400 degrees.

In regard to Figure 8, that you mentioned, the solid line and the broken line, they are two lines on the same curve with the same coordinates. The broken line in that case is simply a second set of tests; in other words, the solid is test No. 1 and the broken is test No. 2, both on the same slab and in the same furnace.

H. H. Dinneen: The method described for obtaining slab temperatures will undoubtedly be a powerful tool in the further development of the reheating furnace. The temperature data obtained by these methods should prove invaluable to both furnace operators and designers. From the results of these tests, Mr. Percy has pointed out several questionable features of the furnace, one being the desirability of the soaking zone. I would comment further on the function of this zone and related furnace factors which affect the operation of this part of the furnace. The so-called soaking zones in these furnaces are intended to equalize the steel temperature, remove the skid marks, and provide uniformly heated slabs for the mill. The furnace, properly operated at feasible capacities, can deliver slabs to the soaking zone with the surface at rolling temperature or slightly above. These slabs would contain sufficient heat so that they can be equalized and soaked before being discharged. The temperature differential of the slabs entering the soaking zone will vary with the capacity, the differential becoming greater as capacity increases.

In looking over Mr. Percy's curves, I was unable to come to any exact mathematical conclusions. However, I would point out that a number of these furnaces under test are operated at excessive capacities, and at times over-heated slabs as well as under-heated slabs are pushed into the soaking zone, and it can be reasoned that in either case a decided drop in the surface temperature of the slabs will occur.

The discussion this afternoon has turned toward what can be done to these furnaces to adapt them for very high capacity operation. It should be borne in mind that the furnaces under discussion were designed with the idea of maximum fuel economy at a certain capacity, which is in accordance with Mr. Trink's statement. However, furnaces are now being designed to obtain the maximum possible capacity per square foot of hearth consistent with a uniformly heated product. These furnaces will utilize higher heat transfer rates throughout the heating zone than those under discussion. This design will impart more heat to the steel before it approaches the soaking hearth resulting in a lower temperature differential between the surface and center of the slabs. Such slabs will have sufficient time to equalize before leaving the furnace.

These comments are offered with the idea in mind that this extreme capacity operation in a number of cases may have influenced Mr. Percy's tests, which have led him to the conclusion that the soaking zone may be undesirable adjunct to a furnace of this type. My personal opinion is that the soaking zone plays an important role when uniformly heated steel must be delivered to the mill.

In those instances where the soaking zone does not perform as an equalizing zone, we feel that some other factor in the operation of the furnace is usually to blame. This may require some explanation.

The soaking zone is intended primarily as a holding

chamber and the heat transfer rate expected is not very great. In fact, the steel entering this zone should contain nearly enough heat to equalize at the proper temperature before leaving the furnaces.

J. W. Percy: You will remember that I was rather careful to qualify my paper in the beginning by saying that undoubtedly some of these results that I showed could not be traced to furnace design but probably a matter of operation. There is no question in my mind but that many of these difficulties come, as you say, from pushing the furnace far beyond its rate of capacity.

In regard to the efficiency that you mentioned, I knew several years ago, of course, that these furnaces were designed to obtain not only maximum heating capacity but also maximum fuel efficiency, and their design was such that you aim to take all the possible heat from the gas by the steel as it enters the charging end of the furnace. However, it is my observation in the plant that as far as fuel efficiency is concerned, most of these furnaces are pushed pretty hard, and in my estimation they put a lot more fuel through them than can possibly burn in the furnace, so I do not think the fuel efficiency amounts to a great deal, although that is certainly not saying anything against the design itself.

I don't want to drag furnace design into this discussion now, as there are so many ramifications. The reason I mentioned the fact that I wasn't sure the soaking zone was necessary was based entirely upon what you saw in one of the earlier figures, in which the center temperature and the surface temperature of the slabs were essentially the same as they passed under the knuckle of the furnace or into the soaking zone, and after it went into the soaking zone the surface temperature dropped, and it was somewhat, in one case, below the center temperature as it was pushed out to the roll table. If that is the case, why burn fuel on the soaking zone if you are not going to do any good with it?

H. H. Dinneen: That curve puzzled me in that the discharge temperature is only around 2000 degrees. Was that a high carbon or alloy steel slab being heated?

J. W. Percy: That particular slab was ordinary low carbon strip.

E. C. McDonald: Your tests show the slabs at rolling temperature on entering the soaking zone. This means the soaking zone was used to equalize heat and remove skid marks. What rate of production existed on the furnaces when the tests were run?

J. W. Percy: Those particular tests, I would say, were run under pretty normal circumstances and at a fairly high rate of rolling, somewhere around the capacity of the furnace, and maybe slightly in excess of it.

H. H. Dinneen: It appears to me that the soaking zone in the case you cite must have been cold, which is not a normal situation. The furnace must have been overloaded for a long period, with the consequent reduction in soaking zone temperature. A temperature condition such as you indicate can be obtained under those conditions. That is the only way I can reconcile it, if the operator were intentionally using all the fuel possible in the soaking zone.

J. W. Percy: In that particular case the operator was putting much fuel into the soaking zone. In my estimation, he probably had more fuel in there than would burn; regardless of what he thought, it did him very little good.

In that particular case, those furnaces were not cold. They had been operated for at least eight days before these tests were run, 24 hours a day.

H. H. Dinneen: I don't mean cold in that respect. I mean that the soaking zone temperature was gradually pulled down by the steel going into it at that reduced temperature.

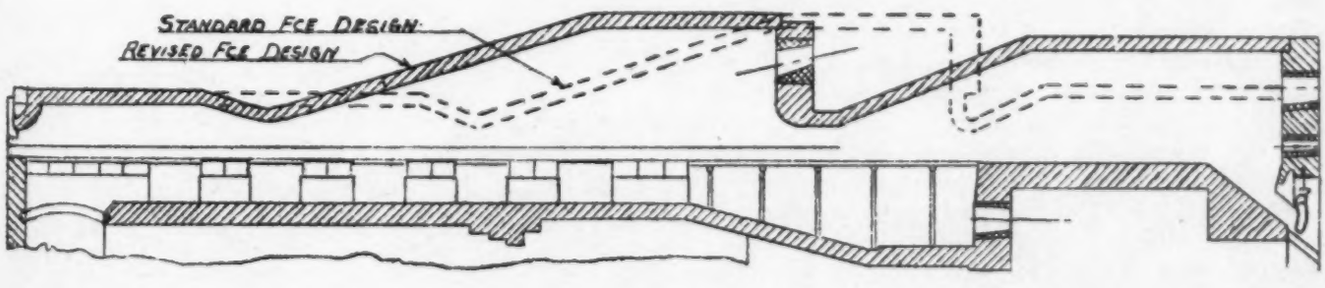
J. W. Percy: The soaking zone probably had been pulled down. The furnace had been running normally for several days before, and in this case, nothing other than roll changes had taken place.

E. A. Vierow: Mr. Percy has presented a most enlightening investigation of the operation of the standard triple-fired slab heating furnace.

It would seem to indicate the uselessness of the "soaking zone" at least in the heating of slabs up to 6 in. thickness. As observed in Mr. Percy's charts, most of the heat transfer in the standard slab heating furnace takes place within a very short distance from the burners of the top and bottom "heating zones," and further that the surface of the steel is actually chilled in traveling through the "soaking zone." This gives an equalized heat at nominal production rates, although the actual "soaking" may do more harm than good metallurgically. Experience has been, however, that when this furnace is forced to very high production rates there is a loss of "heating quality" generally attended by "cinder" formation in the heating zones. Observing Mr. Percy's charts this can be attributed to putting too much heat into too little space.

The answer would seem to be in a more gradual and continuous heating of the slab from furnace entry to

Figure 11 — The proposed furnace design illustrated should give a more gradual and continuous heating of the slab from furnace entry to discharge.



discharge. One method of obtaining such heating is illustrated in Figure 11.

It will be observed from the figure that all three zones are "heating zones" and that each zone is staggered from the others. Among other things, the elimination of co-axial firing of the heating zones permits more heating of the bottom side of the slab before passing to the solid hearth which in turn reduces the "skid-mark" effect. The use of automatic temperature and combustion controls on all three zones makes possible very high production rates and good quality heating without cinder formation.

J. W. Percy: The design you suggest is very interesting and seems to have distinct possibilities. I certainly agree with you that in my opinion it is not necessary to "soak" a slab for any great length of time. When the slab has reached rolling temperature, surface and center, and the skid marks are no longer strongly visible, the slab is ready to roll. I see nothing to be gained by a long "soaking" time.

A. J. Fisher: We have found that variations in furnace pressure of the soaking zone of a three-zone furnace can result in the slabs being either heated, soaked or cooled.

For example, on our three zone furnaces at the hot strip mill, the control panels and operating push buttons were originally between the furnaces. Because of excessive ambient temperatures at this point, the furnace operators tended to maintain low furnace pressures in the soaking zone of the furnace, with the result that cold air entering the discharge door tended to cool the slabs in the soaking zone. We have recently relocated both control panels and operating push buttons so that the furnace operators are not subject to the excessive temperatures and consequently operate the soaking zones at higher furnace pressures. We have found that air infiltration through the discharge doors has been reduced, that oil consumption on the soaking zone has been reduced from 120 to 80 gallons per hour, and that the slabs are now being soaked instead of cooled. In addition to increasing furnace efficiency, the new location of controls is exceedingly popular with the furnace operators.

In the new furnaces which are proposed for our new 68 in. hot strip mill, we have gone one step further in reducing air infiltration into the soaking zone. We are putting flue gas outlets in the discharge inclines of the furnaces. These outlets are connected to eductors which draw flue products out of the discharge end instead of allowing cold air to enter the furnace through the discharge door.

Regarding the effect of furnace length on efficiency which Mr. Trinks pointed out, it is interesting to note that the length of the proposed furnace is 90 feet instead of 75 feet as are the older furnaces.

J. W. Percy: There doesn't seem to be much question but what furnace pressure is important. While we usually take that data during these tests, thus far we haven't taken it into consideration.

J. D. Keller: It seems to me that possibly this present questioning of the value of the soaking zone may have something to do with some of the things that have not been mentioned in the present paper at all; that is to say, not so much the absolute value of the temperature, but variations of temperature as affecting the scale.

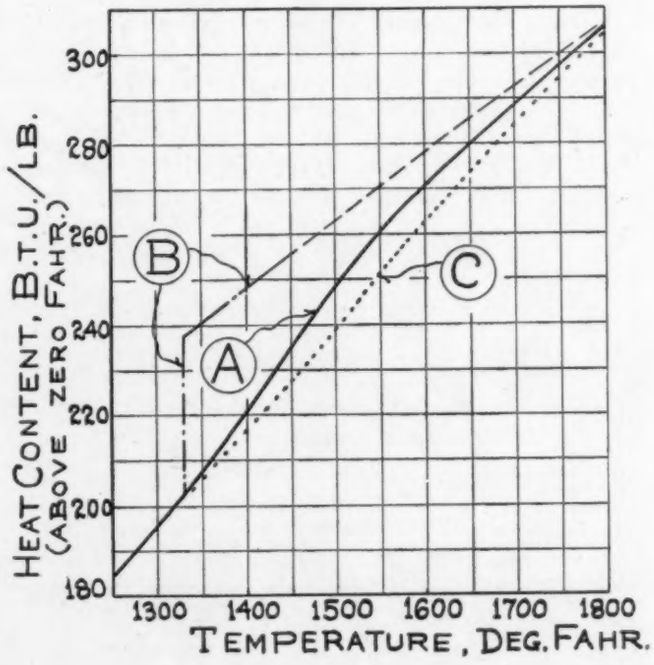
Some engineers have claimed, I don't say this of my own knowledge, that when you push the slabs through the heating zone and you get them up on that part of the curve, you are getting pretty near the dripping or washing stage, and they claim that when that has happened, and you then send them under the knuckle of the furnace roof into the soaking zone, you have a cooling, and in the usual operation you do have at least somewhat of a reheating in the soaking zone. They claim that if that happens, first a cooling and then re-heating, you have produced a scale which is very sticky or adherent, especially sticky in spots, hard to get off, and causing all kinds of difficulty in the rolling process.

I wonder if, aside from the temperature measurements, some of the present reaction against the idea of the soaking zone may not have been due to that.

Referring to the question raised by Mr. Bloom, as to why Mr. Percy's curves do not show the typical arrest of temperature rise at around 1350 F, while it is possible that in Mr. Percy's tests the slabs may have happened to pass through the critical range while they were between the doors of the furnace where their temperature could not be measured, the same absence (or at least partial suppression) of the temperature-arrest phenomenon was found by Mr. Bloom and others in tests of the heating of stationary steel bars where continuous temperature measurements were taken. I believe the following to be the explanation.

In Figure 12 which shows a part of the curve of heat content of low-carbon steel as related to temperature, the results of determinations of heat content by the usual method, in which the test specimen is heated at a moderate rate, are indicated by curve A. But Esser and Grass in tests published in 1933 showed that when

Figure 12 — These curves give data on heat content of low-carbon steel as related to the temperature.



the specimen was heated at a very slow rate, the absorption of heat in the critical range occurred within a very small range of temperature, curve B, corresponding to a true latent-heat absorption. This means that a time effect is involved; the transformation which causes latent heat absorption does not occur instantly. Consequently, if the heating is fairly fast, the transformation is not completed until the temperature has risen considerably, and the absorption of heat is spread out over a range, as in curve A, instead of occurring at a definite temperature. If the heating is still faster, it is reasonable to suppose that the latent heat absorption will be spread over a still wider range of temperature, as in curve C.

This effect also accounts for the fact that the temperature-arrest at points near the surface of a thick bar or slab not only is much less pronounced but occurs at a higher temperature, than at points near the center. The rate of heating, in degrees temperature rise per minute, is much faster at the surface than at the center, in the case of thick bars. The heat absorption at the surface therefore follows curve C while that at the center occurs according to curve A.

J. W. Percy: Your comments are extremely interesting, Mr. Keller, and offer a good explanation for the lack of appearance of the critical point. As I said before, in some cases there seems to be a slight indication of the critical, but in others it takes a lot of imagination to find it.

Victor Paschkis: The author is to be congratulated for a clear and concise method of determining temperature-time relationship of slabs. A few comments are offered not as a correction but rather as an addition:

1. The curves, Figure 6, are of particular interest. If the lower temperature reached at the surface after 200 minutes of heating are sufficient, then the higher temperature previously reached may be a waste of heat.
2. In comparing the heating curves for the 4½ in. slab and the 6 in. slab, both C-steel Figure 7, it is surprising that both should be heated to the same temperature (both surface and center temperatures seem to be identical for the two slabs), notwithstanding the different thickness. It might be expected that the 6 in. slab either would take longer to reach the same temperatures as the 4½ in. slab, or that in the same time (say 120 minutes) the 4½ in. slab heats to a greater degree of uniformity than the 6 in. slab.
3. The entire problem of proper time in furnace and proper furnace temperature should be considered in the light of the desired temperature uniformity of the slab, at the moment of introduction into the rolls. During the time of transfer from the reheating furnace to the rolls a temperature drop takes place, particularly in parts of the slab close to its surface. From this viewpoint it is undesirable to have a temperature of the surface lower than at the center, when the slab leaves the furnace. The surface temperature is bound to drop still further, before the slab reaches the rolling mill.
4. The curves would gain considerably in importance if the furnace temperature, temperature of the gases and of the brick work, were added. They would allow an interesting calculation of heat transfer coefficient.
5. It is desirable to establish a certain permissible temperature range, within which the slab must be heated. From Figure 7 it may be assumed that a temperature between 2400 and 2100 F is acceptable. If such limits were established the necessary heating time and the proper distribution of the furnace temperature could be determined, e.g. by the means of the electric analogy method.

J. W. Percy: Mr. Paschkis' comments indicate a very careful reading of the paper. In regard to paragraph (1), the lower temperatures are not sufficient but represent a distinct loss in rolling quality, I believe. With reference to paragraph (2), please remember that these temperatures were taken at only two points, one at the center, and just above that point on the surface, neither may be average. It is entirely possible that the 4½ in. slab was more uniform in temperature, throughout, than the 6 in. slab. We seem to be in full agreement on paragraph (3). Referring to paragraph (4), we did take measurements of the total radiation at each door of the furnace. In our own studies, these are taken into consideration, but to avoid complication they were not included in this paper. In general it appears that the greater the value of the total radiation, the higher the surface temperature. On paragraph (5), I believe that in most cases, a range of 2100 to 2300 would prove satisfactory. Such calculations as you suggest, by means of electric analogy, would be extremely interesting to me, and a means of checking our observed data.

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FIRE PREVENTION AND SAFETY IN BY-PRODUCTS AND BENZOL PLANTS

. . . . safety in a by-product and benzol plant is dependent on proper plant design, care in operation, and adequate fire fighting equipment and personnel . . . .

By R. W. SCHIRMER
Vice President and Chief Engineer
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▲ BY-PRODUCT and benzol plants are extremely hazardous from a fire and safety to life standpoint. Past experience and loss records compiled by the National Board of Fire Underwriters bear out this statement only too well. The proper methods of safe installation of all equipment and the inauguration of safe operational practices present a very serious problem, as well as do the effective means of combatting and extinguishing any possible fire originating in these plants. In order to clarify this discussion we should, therefore, approach the problem from the following three angles: first, proper, safe installation of all equipment with all possible precautions being taken for the prevention of fires; second, inauguration of all known safe practices in operations so as not to defeat the purpose of preventive measures inaugurated in the construction of the plant and equipment; third, the provision of adequate fire fighting equipment of a type suitable for the hazards involved, and the maintenance of an efficient, properly trained private fire fighting brigade within the plant.

The following suggestions should be considered in the light of constructing a new plant and inaugurating the best known fire prevention and safety measures and practices in that plant. It is realized that the application of these measures in existing plants will naturally be tempered by actual physical conditions and the availability of funds necessary for making any changes required.

The problems will be discussed in the order mentioned above.

SAFE INSTALLATION OF EQUIPMENT

Plant should be located in non-congested area and reasonable safe distances should be provided between individual buildings, scrubbers, agitators, tanks, loading racks, etc., within the plant. These distances should be great enough to eliminate the exposure hazard between individual buildings, and should also provide space for roadways which may be used by the public fire department in approaching any one of the individual buildings, tank areas, loading racks, etc.

All buildings, equipment, tanks, etc., should be properly grounded. It has been our experience that adequate, safe, grounding, can only be obtained by using what we term a network or gridiron grounding for the entire area. No. 2 bare copper wire should be imbedded underground in a gridiron pattern throughout the tank storage and loading dock area, this gridiron to be permanently grounded by 1 in. copper weld ground rods, 8 ft long spaced at approximately 30 ft intervals throughout the gridiron systems. In addition to these ground rods, the gridiron cable should also be brazed to some cold water main which is buried in this area. All connections from above ground equipment to this gridiron ground should be made with approved No. 2 stranded copper cable with approved solderless cable connectors.

All railroad tracks entering the plant area should be properly insulated from the tracks inside of the plant area, and all tracks inside of the plant area should be properly bonded and grounded. The grounding of these tracks should be interconnected to the general gridiron grounding system for the entire area. All piping at the loading dock should be grounded to the general gridiron ground system, and approved ground strap clamps should be installed around all swivel connections on this piping. No. 4 extra flexible stranded copper cable should be used to complete the ground connection to the tank car body, and the tank car dome, and these connections should be made with screw clamp type connectors with contact points to penetrate the steel work on the car.

All ground connections to tanks, fences, building columns, loading piping and tracks must be above ground so as to be available for inspection. All pipe

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lines, motors, machinery and frames must be grounded to the general gridiron ground system.

All electric wiring inside of buildings should be of the approved explosion proof type, and all fixtures, switches and motors should also be of the approved explosion proof type. All lighting outside of buildings in the yard area should be of the approved vapor proof type.

Too much emphasis cannot be placed upon the proper, safe grounding of all equipment and installation of approved wiring for these hazardous areas, as we all know that the least little ignition point, whether it be from an actual electric spark or a static spark, might be the cause of a disastrous fire.

Extreme care should be exercised in the handling of metal drums, buckets, or cans in both the benzol building and loading dock areas. Under no conditions should these containers be dragged across concrete floors or allowed to come in contact with metal piping or equipment. Flexible ground connections should be provided for drums and these connections should always be made before filling operations are started.

Storage tanks should be enclosed in dyked areas so as to prevent any possibility of liquids from a ruptured tank flowing along the ground within the plant area. Tanks containing class 1 or class 2 liquids, that is, tanks containing any liquid with a flash point below 75 F should be enclosed in individual dyked areas, each dyke area to be capable of holding a capacity of not less than 1½ times the capacity of the dyked tank. Where physical conditions prohibit the erection of a dyke of this relative capacity, it is permissible to use dykes of smaller capacity, draining them by means of a 12 in. sewer tile to a confined area remote from the plant. This procedure, however, should be used only as a last resort.

In considering the dyking of tanks the following general rules may be followed:

Individual tanks for class 1 liquids, that is, those liquids having a flash point below 25 F, of 10,000 gallon capacity or over should be enclosed in dyked areas unless the tank is located a minimum of 200 ft from adjoining property or equipment.

Individual tanks for class 2 liquids, that is, those liquids having a flash point above 25 F but below 75 F, of 20,000 gallon capacity or over should be enclosed in dyked areas, unless the tank is located a minimum of 100 ft from adjoining property or equipment.

Individual tanks for class 3 liquids, that is, those liquids having a flash point above 75 but below 200 F, of 50,000 gallon capacity or over should be enclosed in dyked areas, unless the tank is located a minimum of 50 ft from adjoining property or equipment.

All storage tanks should be equipped with approved, protected vents. It is our opinion that the total protected venting area on any one tank should be equivalent to two and one-half times the total cross sectional area of the inlet or suction piping to the tank, depending upon which is the larger. A minimum of two independent vents should be required on all tanks. Under no conditions should there be any unprotected openings of any kind on tanks in which either class 1 or class 2 liquids are stored. Roding hatches should be equipped with approved flame arrestor type protective equipment and it is suggested that the base of the protective screen in the roding hatch opening be securely anchored to the bottom of the tank so as to prevent undue vibration which would result in rupture to the screen, caused by the surge action of the liquid in the tank.

The use of open pipe trenches throughout the plant area should be prohibited. Piping between buildings, agitators, tanks, scrubbers, etc., should be run overhead or buried underground. Where the piping is buried underground, it is permissible to provide small manhole sumps at piping joints but under no conditions should these sumps be located at less than 40 ft intervals so that any leakage which may develop in pipes can be easily detected and corrected.

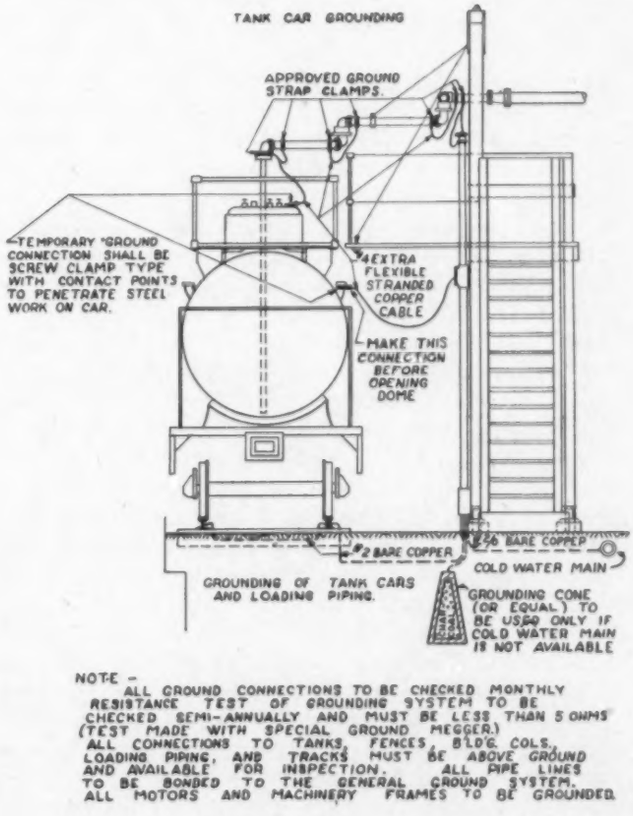
It is suggested that all steel valves and fittings be used on all piping. Piping connections to storage tanks should be made at top of tank wherever possible so as to prevent the possibility of contents of tank being emptied through breakage of pipe line.

If proper precautions are taken in the original installation of buildings and equipment in these plants, a major stride has been taken in the prevention of a disastrous fire after the plant has been put in operation

SAFE PRACTICES IN OPERATIONS

It is acknowledged that smoking should be absolutely forbidden within the plant area. The carrying of matches or smoking materials inside of the plant should be prohibited, and receptacles should be provided at the

Figure 1 — Both dome and body of tank cars should be properly grounded when being loaded and unloaded.


TANK CAR GROUNDING
APPROVED GROUND STRAP CLAMPS.
TEMPORARY GROUND CONNECTION SHALL BE SCREW CLAMP TYPE WITH CONTACT POINTS TO PENETRATE STEEL WORK ON CAR.
#4 EXTRA FLEXIBLE STRANDED COPPER CABLE
MAKE THIS CONNECTION BEFORE OPENING DOME
#2 BARE COPPER
#6 BARE COPPER
COLD WATER MAIN
GROUNDING OF TANK CARS AND LOADING PIPING.
GROUNDING CONE (OR EQUAL) TO BE USED ONLY IF COLD WATER MAIN IS NOT AVAILABLE

NOTE - ALL GROUND CONNECTIONS TO BE CHECKED MONTHLY RESISTANCE TEST OF GROUNDING SYSTEM TO BE CHECKED SEMI-ANNUALLY AND MUST BE LESS THAN 5 OHMS (TEST MADE WITH SPECIAL GROUND MEGGER.) ALL CONNECTIONS TO TANKS, FENCES, BLDG. COLS, LOADING PIPING, AND TRACKS MUST BE ABOVE GROUND AND AVAILABLE FOR INSPECTION. ALL PIPE LINES TO BE BONDED TO THE GENERAL GROUND SYSTEM. ALL MOTORS AND MACHINERY FRAMES TO BE GROUNDED.

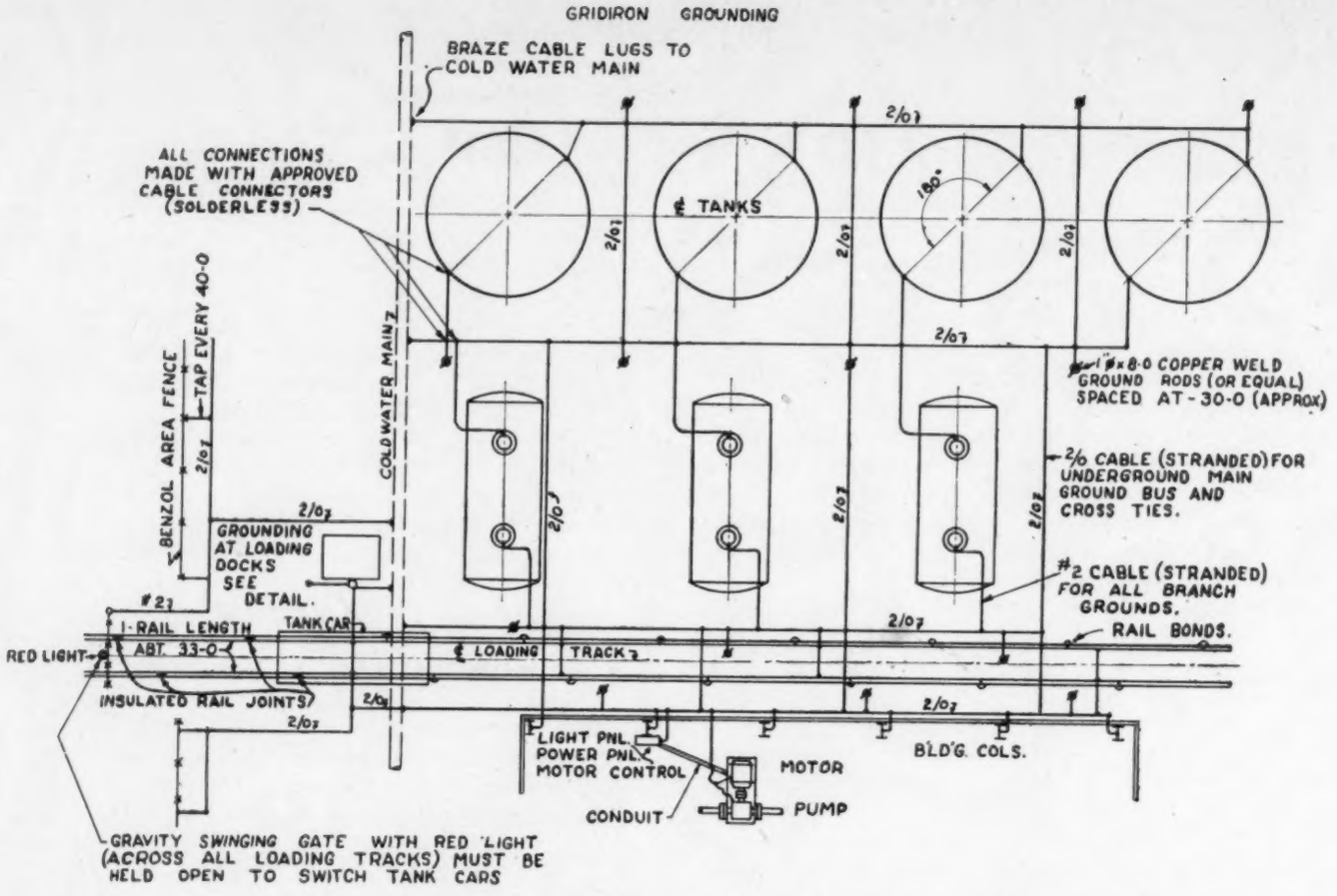


Figure 2 — All equipment in the tank area should be grounded, since the smallest spark may be the cause of a disastrous fire.

entrance gates so that employees may deposit these materials before entering the plant.

The entire plant area should be enclosed in a man-tight fence and all gates in the fence to the plant area should be locked from the inside. Specific instructions should be issued to employees to permit only authorized persons to enter this area. The fence enclosing the plant should be equipped with escape gates which open out, by means of a panic bar or some similar arrangement, so that in the event of a serious fire or explosion, employees would be able to evacuate the area in the quickest possible time.

Extreme care should be taken so that all employees are thoroughly familiar with the hazards inherent to their individual job. They should be entirely cognizant of all general hazards in the plant and properly instructed in the most safe practices as to their own job.

All ground connections should be rigidly checked every month, and a resistance test of the grounding system should be made semi-annually. If this resistance test reveals an excess of 5 ohms, proper corrective action should be taken immediately.

Definite instructions should be posted at the loading dock stating that tank cars to be loaded or unloaded should be properly grounded both on the tank car body and on the tank car dome before any work of any kind is done on the tank car. These instructions should be rigidly enforced.

All vents and flame arrestors should be examined weekly for signs of corrosion and any necessary repairs or replacements should be made immediately. Dykes enclosing tanks should be inspected at monthly intervals to ascertain that there are no leaks in these dyked areas. Dyked areas should be kept clean at all times and the accumulation of oil, refuse, etc., in these areas should be prohibited.

If it becomes necessary to use burning or welding equipment in the plant, this should be done only under the direct supervision of the plant protection department and plant fire marshal. The plant fire marshal should take all known precautions while this equipment is being used, and additional first aid fire protection equipment should be made available at the burning or welding location.

All tools, including wrenches, hammers, screw drivers, pliers, bars, etc., used in the plant should be of the approved non-sparking type. This is very important as the use of one ordinary tool, at the wrong place at the wrong time, might very easily be the cause of a disastrous fire or explosion.

Weekly inspections should be made of all lighting equipment and any cracked or broken explosion or vapor proof globes on lights should be replaced immediately.

Plant and yard areas should be maintained in a clean and orderly condition at all times, and the accumulation of refuse should be prohibited. Approved waste cans

should be provided at all necessary locations for oil and grease soaked rags that might be used in the general maintenance of the equipment.

Regardless of how safe a plant may have been constructed, or to what extent modern safety precautions have been incorporated in the installation of the equipment, safe operating practices must continually be maintained to prevent disastrous fires or accidents.

This is a continual problem that requires extreme vigilance on the part of both plant management and labor.

ADEQUATE FIRE FIGHTING EQUIPMENT

A private yard main and hydrant system should be installed within the plant. No fire main should be less than 6 in. in size and the water supply to this yard main and hydrant system should be capable of supplying at least 3000 gallons of water per minute at a pressure of not less than 100 lb. Standard fire hydrants should be connected to this yard main spaced at approximately 400 ft intervals. These hydrants should be located so as to be not closer than 50 ft from any building. Each hydrant should be equipped with a standard hose house containing 250 ft of approved 2½ in. cotton, rubber lined hose, nozzle, spanner wrenches, etc. It is also suggested that a hose cart with 500 ft of reserve hose be located at a central point so as to be available for use at any one of the hydrants provided.

It is suggested that all storage tanks exceeding 75,000 gallons in capacity be equipped with a permanent piped external cooling system controlled by an accessibly located remote control valve. The purpose of such a cooling system is to maintain the liquid stored in the tank at temperatures below its ignition point in event of an exposure fire.

A 2 in. water line connected to the fire mains should be installed at the top center of each vertical storage tank. Deflector plates should be installed around the tank so as to deflect the water from the tank roof on to the vertical side sections of the tank. A ½-inch opening should be provided between tank and lower edge of deflector plates. Supply piping to this cooling system will be normally dry and controlled by the remote valve mentioned above.

Permanent piped steam jets should be installed in all main sewers, controlled by accessibly located valves at several strategic points.

A fire-resistive constructed foam generating station building should be provided. This building should house two foam generators, one of which should be equipped with powder bins, and the other arranged for manual feeding of the powder. This building should be steam heated by means of steam coils or radiators.

The foam system should be of the approved two line types. A 500 gpm, 100 psi, electric driven manually operated booster pump, taking suction from the yard main system should be installed on by-pass line ahead of the foam generators. All electric service lines to pump motor and control panel should be buried underground in protected cable.

Foam generating station should be connected by permanent piping to a separate hydrant system, so that foam hydrants are located in the vicinity of the tank storage, loading dock area and benzol washers. All tanks containing class 1 or class 2 liquids should be provided with permanent piped foam protection, and the intercepting sump should be equipped with this same protection. Naphthalene pans should be protected with permanent water fog equipment controlled by approved rate of rise thermostats.

Pump rooms and benzol building proper should be equipped with carbon dioxide extinguishing equipment, permanently piped into these buildings and controlled by approved rate of rise thermostats, and also by manual controls located outside of these buildings.

Benzol building and pump houses should be fitted with explosion type sash. Ventilators should be installed in roof, fitted with fan, equipped with explosion proof motor for down-drafting. Louvers protected by flame arrester screens should be installed in exterior walls at floor level.

An adequate supply of approved first aid foam, carbon dioxide and carbon tetrachloride type extinguishers should be provided in all buildings for use in extinguishing any possible small fire originating in these areas.

It is suggested that a permanent pipe connection be made at the loading dock to be inserted in tank car dome before each filling operation. This piping should be connected to two 50 lb carbon dioxide cylinders with a manual control valve located at a safe distance from the loading dock so that tank car may be flooded with carbon dioxide in the event of fire.

A new development in fire fighting equipment applicable to benzol plants has recently been placed on the market. This is known as a "Phomaire" nozzle and is used on a regular 2½ inch hose line with small applicator to pick up a "Foamaide" liquid. This equipment has been tested and approved by the Underwriters' Laboratories.

The use of this nozzle on a hose line gives an unlimited supply of foam for combating a volatile liquid or oil fire. It is suggested that two of these nozzles be provided as standard equipment in the plant and that an ample supply of the liquid be kept on hand.

Key employees on every shift should be organized into a private fire fighting brigade under the direct supervision of a competent full time plant fire marshal. These men should be instructed in detail as to hazards involved in the plant and the proper methods of fighting any possible fire. A fire alarm system connected to audible sirens within the plant area and to the plant protection office should be installed. This alarm should be controlled by fire alarm switches conspicuously located at several points within the plant. Definite instructions should be issued to the plant protection office to immediately call the public fire department upon receipt of any alarm.

Experience proves that the slightest delay in transmitting an alarm of fire may result in serious consequences and too much emphasis cannot be placed upon the prompt transmission of such an alarm.

The general subject of fire prevention and safety in by-products and benzol plants covers an immense amount of territory and no attempt has been made in

this paper to enter into all the details connected with such a program. This paper has followed along general lines. Every individual plant would have many specific problems which would have to be approached on their own merits. Recommended corrective measures would have to be suggested for each individual problem.

However, the subjects touched upon in this paper and the suggestions made can be used as a general formula for preventing fires in these plants and for improving the general safety conditions under which the employees work.

DISCUSSION

PRESENTED BY

E. H. HOUCK, Superintendent of Safety and Welfare, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

R. W. SCHIRMER, Vice President and Chief Engineer, Hendricks Engineering Corporation, Chicago, Illinois

E. H. Houck: Assuming the average railroad tank car is being loaded with benzol at the ordinary loading dock, and assuming that the tank shell and dome and the loading spout have been properly grounded against static sparks, do you feel that in addition to that, a portable manhole or dome cover provided with flash-back screen arrangement should also be used?

It has been a problem with us as to what to use, and whether it would be effective. The operators do complain that when covering the manhole dome they can't quite judge when the contents may run over.

R. W. Schirmer: If the grounding connections have all been made as you stated, we don't feel that the protecto-seal or an approved, protected dome cover is essential.

We do feel, however, that this innovation of providing a permanent carbon dioxide connection, that is, a pipe with which you can flood the car with carbon dioxide in the event of trouble, is better than the protective dome covering, because as you mentioned, you cannot gauge the contents. In our experience of inspecting plants all over the country, we generally find the protected dome cover back in the shed, where it has probably been since shortly after it was purchased.

E. H. Houck: That has been our experience. One more question, speaking about the tank dikes around storage tanks, it has been a problem with us to select the material to use for construction. Of course, costs come into the picture, but do you have any recommendations as to first, second, and third preference? I have in mind reinforced concrete or brick or the earthen dike. Do you have any recommendations along that line?

R. W. Schirmer: The problem of dikes brings up the point, do you have the room to put the dike around the tank?

In a good number and a large percentage of the plants, there is not adequate physical room, to put up a dike that will hold one and one-half times the capacity of the tank. Then we have to use a smaller dike and drain it to some remote area such as a field or a swamp. In the case of a small dike, it definitely has to hold the contents and drain it to the sewer, and for that we would recommend reinforced concrete as a good second choice for a good, substantial wall. The only time we suggest or approve an earthen dike occurs when the tank is located in an area large enough to put up a substantial earthen dike. You must have at least five or six feet for the base to make it effective for the height that you want.

Maintenance Kink
FOR ROLL WELDING

Below is shown an excellent example of the technique of "roll welding." A block and fall is rigged at each end of the 6 in. pipe line being welded. By unwinding, the pipe is turned, allowing the welder to work in the flat or downhand position, thereby increasing the speed of operation and assuring sound welds.

PLUGGING METHODS
FOR MILL AND CRANE MOTORS

. . . . discussing the familiar plugging methods used on standard mill and crane controllers, as well as the new rectifier plugging method which offers possibilities of reliable and consistent plugging with a minimum number of operating devices . . . .

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▲ ONE feature required on many mill and crane drives is automatic plugging control of the driving motor. A controller designed for plugging operation is one which permits connecting the motor to the line in the reverse direction while the motor is still rotating in the forward direction. This is desirable for many applications to obtain rapid reversal or for stopping a machine without dynamic braking or mechanical brakes. Brakes are sometimes provided only for holding or emergency stopping. Magnetic type plugging controllers for direct current motors will be discussed and a scheme using rectifiers in the plugging control circuit will be described.

When a motor is running it generates a countervoltage which opposes the line voltage. The line current is determined by the difference between impressed voltage and countervoltage divided by the motor circuit resistance, see Figure 1. When the motor is stopped, the countervoltage is zero so the line current is only limited by the motor circuit resistance. It is equal to the impressed voltage divided by the motor circuit resistance. When the motor is plugged, the countervoltage is in the same direction as the impressed voltage instead of opposing it, so the line current is much greater, assuming equal armature circuit resistance. It is equal to the sum of the impressed voltage and countervoltage divided by the armature circuit resistance.

An easy example for explanation purposes would be an application with a shunt type motor. The countervoltage while running at rated speed and rated load may be about 90 per cent of the impressed voltage. If an accelerating resistor is selected to allow a certain inrush current with the motor stalled, the current obtained when the motor is plugged from rated speed will be approximately 190 per cent of the starting current, usually the accelerating resistor is designed to provide a starting current of about 150 per cent of motor rated current and approximately the same accelerating peak currents as each accelerating contactor closes. If the motor is plugged from full speed with this resistor, the plugging current will be $1.5 \times 1.9 \times 100$ or 285 per cent of rated current. It is desirable to keep the plugging current equal to or slightly less than the starting and accelerating peak currents. This requires inserting additional resistance in the armature circuit when the motor is plugged. The extra resistanee for this purpose is called the plugging resistor to distinguish it from the accelerating resistor.

A plugging contactor P, is connected to by-pass the plugging resistor as shown in Figure 2. The plugging contactor must be arranged so it may close without delay as soon as one set of directional contactors F or R closes when starting the motor from rest. This provides a normal starting inrush current of 150 per cent. When the motor is plugged, however, the plugging contactor should be prevented from closing until the plugging current decreases to the desired value. The plugging current will decrease as the motor decelerates and the plugging contactor should be controlled to close just before the motor reverses so the next current peak will be approximately the same as when starting from rest.

Curves plotted in Figure 3 show the relation between current and speed for different controller points for a series wound motor and a starting resistor which provides 50 per cent of rated motor current with all accelerators and the plugging contactor open. This is shown on the curve for the first speed point of the master switch. If the motor torque on this point is not enough to drive the load and the master switch is moved to the second speed point the current will be increased to 100 per cent. As the motor decelerates the current decreases as shown by the second speed point curve. If the first accelerator 1A closes at the point indicated on this curve, a current inrush of about 155

Presented before AISE Annual Convention, Cleveland, Ohio, October 3, 1946

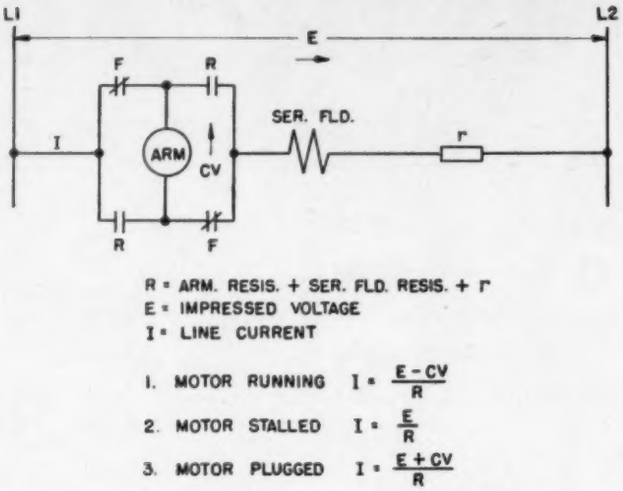


Figure 1 — Motor currents for different operating conditions of this reversing controller are shown in this diagram.

per cent will be obtained as shown for the third speed point curve. The following peak currents will be approximately 165 per cent if the last two accelerators close each time the current has decreased to 100 per cent of rated current. Since series motors are often used to take advantage of the high starting torque characteristics for applications where time of acceleration is an important factor, the running load is normally much less than the motor rated load. The fifth speed point curve indicates that the motor will run at about 215 per cent rated speed if the current is about 25 per cent of the full load value. Plugging the motor at this speed would result in an approximate inrush current of 155 per cent as shown on the curve for the first speed point. If the motor is plugged at 100 per cent speed, the inrush current will be about 95 per cent. The plugging contactor should not close until the motor has decelerated to a speed which will limit the next peak current to a safe value. The second speed point curve indicates a peak current of 115 per cent will be obtained if the plugging contactor, P, closes at about 15 per cent negative speed. Acceleration from this point will be continued the same as when starting the motor from rest.

These curves indicate it is important that the plugging contactor close without delay when starting, to make sure sufficient torque will be obtained to start and accelerate the load. For this reason it should close at zero speed or slightly before zero speed when the motor is plugged. The plugging contactor should never close when the motor is plugged until the motor has decelerated to a proper speed.

Summarizing the foregoing indicates the following factors should be considered in the design of plugging control equipment:

1. The plugging contactor should close without delay when the motor is started from rest.
2. When the motor is plugged, the plugging contactor should not close until the motor speed has been reduced to a speed at which the next current and torque peak will not be excessive.
3. When the motor is plugged, the plugging contactor should always close at the same motor speed.
4. The motor speed at which the plugging contactor closes should not be affected by normal line voltage fluctuations, heating of contactor coils, relay coils or resistors.
5. It should be possible to adjust the accelerating and plugging resistors without disturbing the plugging control settings.
6. A minimum number of operating devices is desirable. This infers that relays and electrical interlocks should be eliminated if possible.
7. A change of adjustment should be easy to make; however, the adjustable members should not invite tampering by unauthorized persons.
8. It should be impossible to adjust the equipment so the plugging contactor might fail to close when the motor is started from rest.
9. Locking methods should be provided so the adjustment cannot change due to vibration, shock, etc.

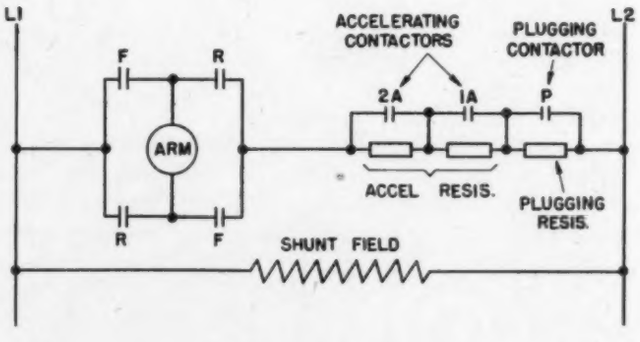
It is not satisfactory to control the closing of the plugging contactor by timing because the motor may not always be plugged from the same speed or decelerate at the same rate. The control method must be governed by the motor speed.

An external device mechanically connected to the motor shaft or driven machine such as a centrifugal, friction type or hydraulic switch may be used to control the plugging contactor. Devices of this type for automatic plugging control are seldom used because more reliable control can be obtained electrically without requiring the installation of separate equipment.

All the methods for the electrical control of the plugging contactor which respond to motor speed are dependent on motor countervoltage for functioning. Countervoltage is the controlling factor, although the controlled device may operate in response to voltage or current. This type of plugging control is generally used on all steel mill and crane controllers.

One of the earlier devices used for controlling the plugging contactor is the series type plugging relay which has its coil connected in series with the plugging resistor as shown in Figure 4. The normally closed contact of the plugging relay PR, is connected in series with the plugging contactor coil. This relay is adjusted so its contact will not open by the current obtained when the motor is started from rest with the accelerating and plugging resistors all in circuit, but will open by the current obtained when the motor is plugged. When starting from rest, therefore, the plugging contactor P, will close without delay to permit a normal starting

Figure 2 — Diagram of reversing controller for shunt type motor.



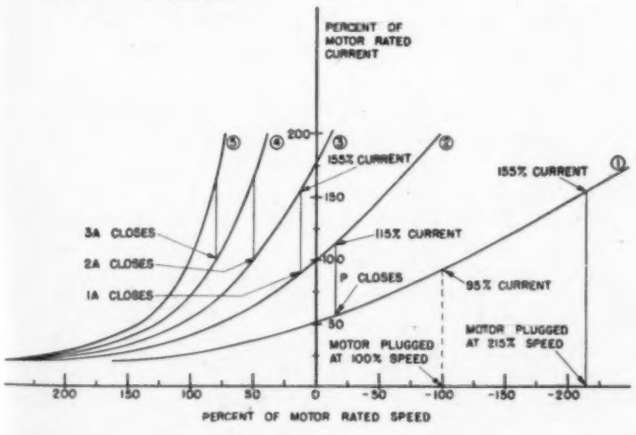
inrush current as limited by the accelerating resistor only. The PR relay is designed for fast response so when the motor is plugged its contact will open before contactor P operates. Since P does not close, the plugging resistance is added to the circuit to limit the plugging current. The PR relay is set to close its contact when the current through its coil decreases to a value obtained just before the motor reverses. The plugging contactor will then close and by-pass the plugging resistor and PR relay coil. The rest of the accelerating cycle is controlled by the accelerating contactors 1A and 2A and their controlling means which is not included in this discussion.

A shunt type plugging relay may be used to control the plugging contactor the same as described for the series type relay. The relay coil is connected across the plugging resistor R1-R2 as shown in Figure 5 and is controlled by the voltage drop across this resistor. The voltage drop across this resistor is greater when the motor is plugged, than when the motor is started from rest. PR is adjusted so its contact will not open on the voltage obtained when starting from rest but will open on the voltage obtained when the motor is plugged. The voltage drop across R1-R2 decreases as the motor accelerates and the PR relay is set to close its contact just before the motor reverses.

The series and shunt type relays are similar in design and it will be noted, the control schemes are essentially the same. Because of the differential between pickup and dropout ampere turns for the foregoing series and shunt type relay, it is desirable to adjust the relay so it will close its contact as close as possible to zero motor speed, before the motor reverses, when plugging. This is desirable to insure that it will open its contact when the motor is plugged from a low speed. Improper adjustment may result in the relay opening when the motor is plugged but not closing before the motor reverses. Because of the operating differential of the relay, this adjustment may be satisfactory for starting the motor from rest but it would result in the motor stalling when plugged with full load.

A method which depends on the algebraic sum of the armature countervoltage and voltage drop across the plugging resistor for controlling the plugging contactor is shown in Figure 6. When starting from rest in the forward direction the armature IR drop is in the same

Figure 3 — These curves show the relation between current and speed on each master point for a series wound d-c motor.



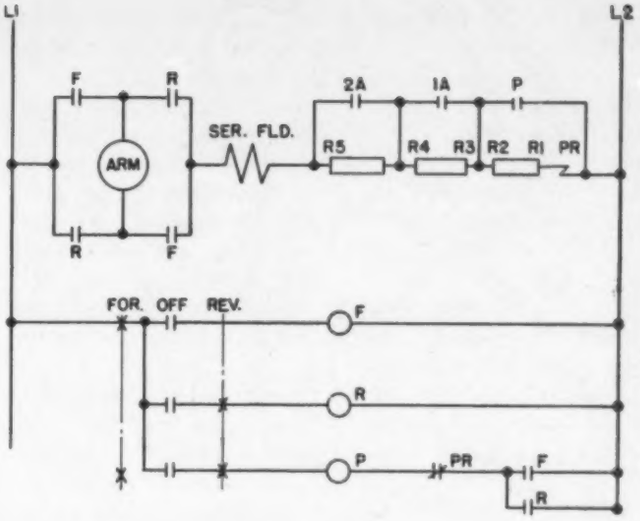


Figure 4 — This reversing plugging controller uses a series type plugging relay.

direction as shown for the countervoltage when running forward. This voltage is added to the IR drop across the plugging resistor R1-R2 and is sufficient to close the contacts of the forward plugging relay PF. This completes the circuit to the plugging contactor coil P, to close the P contactor without delay. When the motor is plugged, the circuit for the reverse plugging relay PR is closed but it is connected to the other side of the armature. The armature countervoltage is still in the same direction as indicated. The closing of the reverse contactor R, connects the armature so this countervoltage is opposite to the plugging resistor IR drop. Therefore, the voltage across the PR coil is the difference between the countervoltage and resistor IR drop. With the proper resistor value for R1-R2, this difference in voltage is practically zero and, therefore, the PR relay contact will not close. As the motor speed decreases, the countervoltage also decreases which increases the voltage across the relay coil. At about zero speed, the voltage across the relay coil is sufficient to close the relay contact. This energizes the plugging contactor coil to close the P contact.

Another method which also employs two plugging relays is shown in Figure 7. Each relay has a normally closed contact and is provided with two coils on one core. One coil is the main coil and is energized to open the contact. The other coil is the adjusting coil and is used to close the relay contact by providing flux to oppose the residual magnetism after the main coil is deenergized. The contact is held open if both coils are energized cumulatively.

Both plugging relay contacts will be opened when the master switch is in the off position. When starting the motor from rest in the forward direction, the main coil PFM is deenergized and the IR drop across PFN produces a flux to oppose the residual magnetism left by PFM. This closes contact PF and completes the plugging contactor coil circuit, to close the P contactor without delay. As the motor accelerates, the countervoltage will increase in the direction indicated. When the motor is plugged, the main coil for the other plugging relay PRM, is deenergized and the plugging con-

tactor coil is transferred from the PF to the PR contact. The countervoltage is still in the same direction as indicated and will energize PRN so the flux will be in the same direction as the residual magnetism after PRM was deenergized. The PR contact, therefore, will remain open. The countervoltage decreases as the motor speed decreases and when the motor approaches zero speed, the polarity of PRN will be reversed. The flux of PRN will then oppose the residual magnetism and contact PR will close to energize the plugging contactor coil. The countervoltage at which the plugging contactor will close can be changed by moving the tap on the adjustable resistor.

Figure 8 shows a method using one plugging relay constructed with a fixed coil and a movable coil on a common magnetic circuit. The fixed coil is permanently connected across the line to provide a unidirectional magnetic field in which the moving coil acts. The movable coil is connected across the motor armature and operates to close contact FR, when the motor rotates forward, and close contact RR when the motor rotates reverse. The relay is designed to operate on the armature IR drop when the motor is stopped. Therefore, when the motor is started from rest in the forward direction, the FR contact of relay PR will close at once. This energizes contactor coil P without delay to close contact P and by-pass the plugging resistor. When the motor is plugged, the armature countervoltage maintains the plugging relay coil polarity to keep contact FR closed and RR open and, therefore, the plugging contactor coil circuit is open. When the motor reaches zero speed, the countervoltage is zero, the motor IR drop then reverses the polarity of the PR movable coil which opens contact FR and closes contact RR. This completes the circuit for the plugging contactor coil to close its contact and by-pass the plugging resistor.

Another single relay method in which the plugging relay is controlled by the direction of motor countervoltage is shown in Figure 9. This relay is constructed with two fixed coils on a common magnetic circuit. One coil is connected across the line to provide a fixed magnetic flux for polarizing the relay. If the second coil is connected cumulatively with the first, the voltage drop across the stalled motor armature is sufficient to close the plugging relay contact. If full voltage is applied to both coils and they are connected differentially, the relay contact will not close. When the motor is started from rest in the forward direction, the plugging relay PR will close without delay so the plugging contactor can close immediately. When the motor is plugged, the connections of the PR coil in the armature reversing loop circuit are changed so the motor countervoltage will reverse the flux of this coil. This prevents the PR relay contact from closing so the plugging contactor coil P will not be energized. When the motor reaches zero speed, the countervoltage is zero. The motor IR drop then reverses the polarity of the armature circuit PR coil to close the PR contact. This completes the P coil circuit and the plugging contactor closes to by-pass the plugging resistor.

By using a plugging contactor which has a closing coil and a holdout coil assembled in one structure as shown in Figure 10, a separate plugging relay is not required. The top coil is the closing coil and the bottom coil is the holdout coil. The relationship of the two magnetic circuits is adjusted so the contactor will be held open with full voltage on the closing coil, and as low as one per cent of normal voltage on the holdout coil. However, even with full voltage on the holdout coil, as soon as the contactor lever starts moving, the holdout effect decreases rapidly so the contactor always closes with full contact pressure and at about the same speed. The characteristics of the holdout circuit may be changed by changing shims in back of the holdout coil or turning the knurled adjusting screw, shown just above the holdout coil. These adjustments should be made so the armature always stops on the brass plug in the center of the holdout core, and an iron to iron seal at this point should never be permitted. The knurled adjusting screw is provided with a stop to limit the amount it can be screwed toward the armature

Figure 5 — Diagram of reversing plugging controller with shunt type plugging relay.

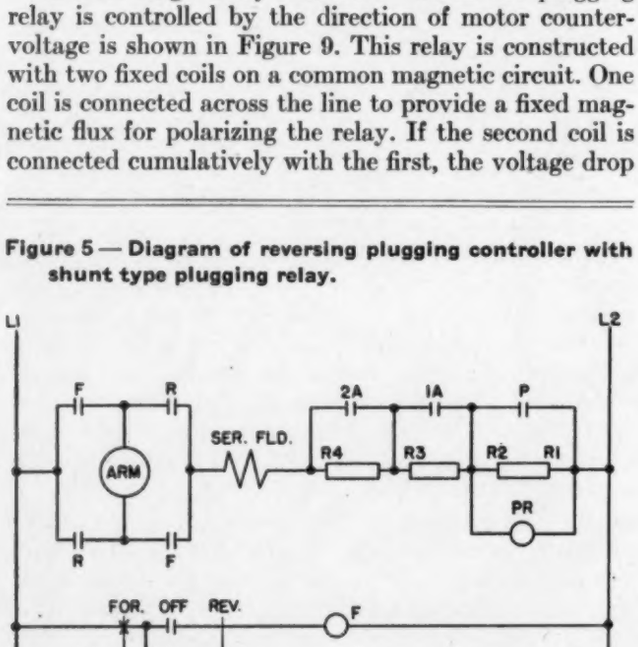
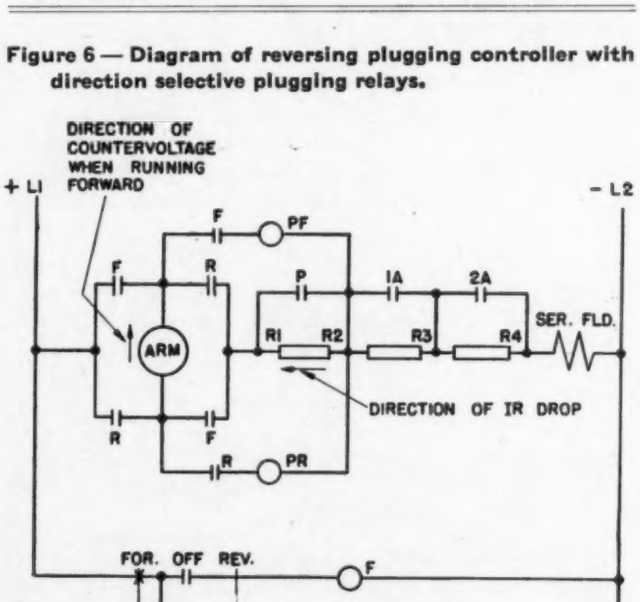


Figure 6 — Diagram of reversing plugging controller with direction selective plugging relays.



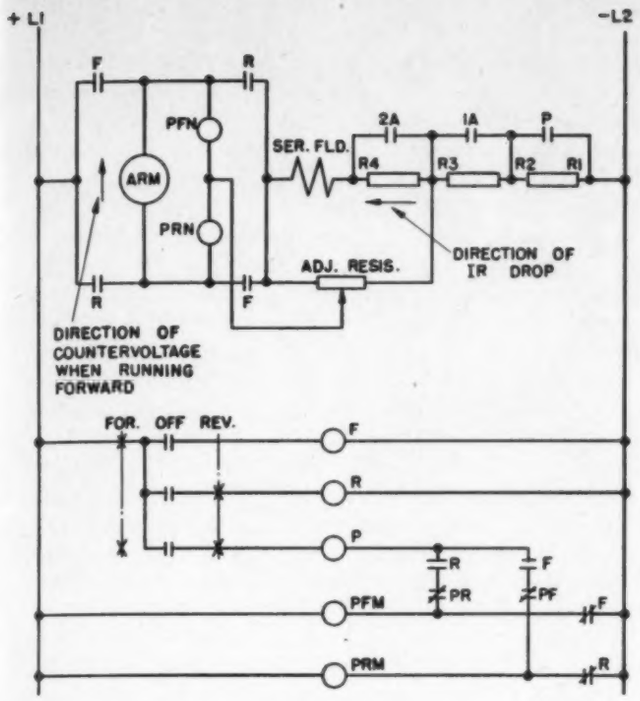


Figure 7 — Double coil plugging relays are used in this reversing plugging controller.

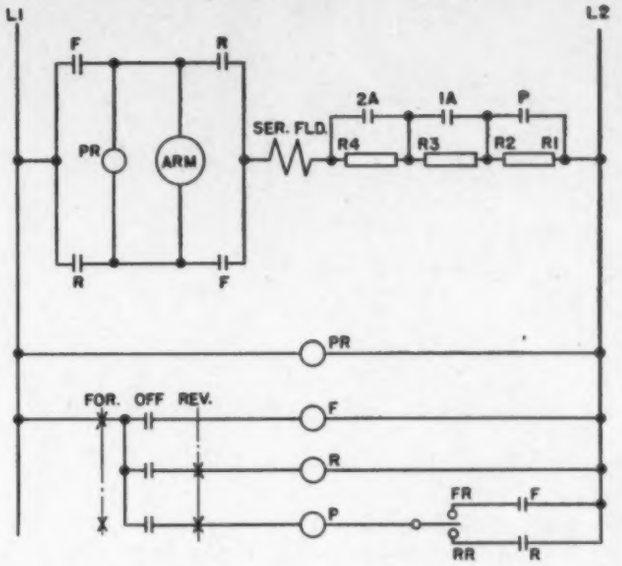


Figure 8 — The plugging relay on this reversing plugging controller is constructed with a fixed and movable coil.

lever. With these adjustments, the contactor can be set to close over a wide range of voltages across the holdout coil with constant normal voltage across the closing coil.

A plugging method using this type of contactor is shown in Figure 11. The holdout coil HCP, is connected across the plugging resistor and the closing coil P, is connected to the control pilot device and back of directional contactor electrical interlocks. The contactor is adjusted so it will close without delay when starting the motor from rest. The voltage across the holdout coil at this time is determined by the voltage drop across the plugging resistor R1-R2. It is adjusted so the contactor will be held open by the voltage drop across R1-R2 which is applied to the holdout coil when the motor is plugged. With the proper adjustment, the plugging contactor should close just before the motor reverses after the motor is plugged.

Control of the plugging contactor which responds to line current or voltage drop across the plugging resistor, will be affected by variations in line voltage and changes in motor circuit resistance due to normal heating or adjustments. In these methods, plugging control is dependent on countervoltage plus line voltage. The series relay shown in Figure 4 operates on current which is proportional to line voltage plus countervoltage. Any method operated by IR drop similar to Figure 5 is also proportional to armature current and, therefore, to the line voltage plus countervoltage. Any of these methods involving line voltage allows the adjustment of the plugging means so that the plugging contactor could lock out at zero speed or after the motor has reversed. Caution is required when making adjustments so the plugging contactor will be sure to close when starting from rest.

Assume the adjustments are made so the plugging contactor closes when the motor speed is zero with normal line voltage. If the line voltage increases above normal, the plugging contactor will not close until the motor has reversed. This is objectionable because the plugging contactor would fail to close on heavy loads when starting from rest, and without sufficient torque the motor would not accelerate. For this reason and to allow for other variables, due to normal heating, it is necessary to set the plugging control means so the plugging contactor will close before the motor speed has reached zero. If the line voltage decreases below normal or circuit resistance increases due to heating, the plugging contactor will close at a higher motor speed.

Any plugging method controlled directly by countervoltage which is not modified by line voltage, reduces variations caused by fluctuations in line voltage. Changes in the starting resistors due to heating or adjustments, will not disturb the plugging control settings. Plugging control can be arranged to prevent any possible lockout of the plugging contactor at zero speed or after passing through zero speed. This method of control appears to have many desirable features.

A method which reduces the number of auxiliary contacts shown in the foregoing methods, eliminates the use of a separate relay and is controlled by the motor countervoltage only, has been successfully employed on a number of installations. The method is referred to as rectifier plugging because a dry type rectifier is used for reversed current blocking control.

A reversing rectifier plugging method is shown in Figure 12. The plugging contactor P is the same type shown in Figure 10. The closing coil P is connected to the control pilot device back of the directional contactor interlocks. The holdout coil HCP, is connected in the motor armature reversing loop with the rectifier and current limiting resistors AB and CD. Polarity of the lines L1 and L2 must be positive and negative respectively as indicated, with the rectifiers connected as shown. The rectifier allows current to flow in the direction indicated by the arrow when the polarity is positive at the junction of the rectifier and the holdout coil. Current limiting resistors AB and CD could be eliminated as far as function is concerned because their

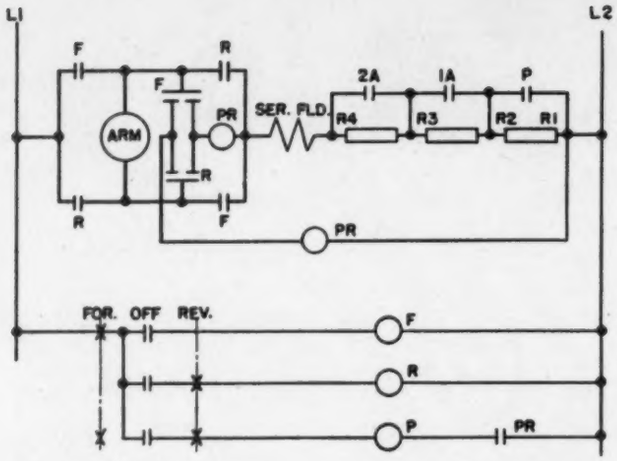


Figure 9 — The plugging relay on this reversing plugging controller is constructed with two fixed coils on a common magnetic circuit.

only purpose is to limit the current in case of rectifier failure. They are recommended for protective reasons.

The diagram in Figure 12 has been separated into several sections and shown in Figures 13, 14 and 15 to explain the operation of the rectifier plugging controller.

A. Starting forward, motor at zero speed — When starting from rest, the countervoltage is zero. A relatively low voltage equal to the IR drop of the armature is applied to the holdout coil and rectifier circuit. The polarity of this voltage is in the direction so current flow would be blocked by the rectifier. Therefore, the holdout coil HCP, is not energized and contactor P will close without delay.

B. Motor running forward — As soon as the motor armature starts rotating, a countervoltage is generated which opposes the line voltage as indicated. This countervoltage increases as the motor accelerates until maximum speed is reached. As the polarity of the rectifier has not been changed, it will continue to block the flow of current. Only a negligible amount of reverse current will flow through the holdout coil. The plugging contactor will not lock out with this amount of leakage current.

C. Plugged, motor running forward — When plugging, all the contactors are opened by the master switch. The reverse directional contactor R is closed. Resistor AB and the first section of the rectifier are by-passed by one of the R contacts; therefore, this section is not shown. The other section of the rectifier and resistor CD are shown because the F contact which by-passed them has been opened. As the motor rotation has not been changed, the direction of the countervoltage is the same as when running forward. The polarity of the countervoltage is in a direction to permit current to flow through the coil HCP, rectifier and resistor CD. This energizes the holdout coil HCP so contact P cannot close. All the armature resistors, therefore, are in circuit to limit the amount of plugging current.

D. Plugged, motor at zero speed — As the speed decreases when the motor is plugged, the countervoltage will decrease and at zero speed the countervoltage is zero. The holdout coil is selected so the plugging contactor will close with about 10 per cent of line voltage across the motor armature. This voltage is higher than the rectifier cutoff voltage so the closing of the plugging contactor is determined by adjustment and is not fixed by the rectifier voltage current characteristic as the countervoltage decreases. The rectifier functions to prevent any possibility of the plugging contactor locking out after the motor speed has been reduced to zero or starts accelerating in the reverse direction. As the motor speed approaches zero and when the countervoltage is about 10 per cent of line voltage, the plugging contactor, therefore, will close to by-pass the plugging resistor. The motor speed will be practically zero when P closes. At this time the conditions are similar to those for starting as described for A. A voltage equal to the armature IR drop is applied to the holdout coil and rectifier circuit with polarity as indicated. With this polarity on the rectifier, current flow will be blocked.

E. Motor running reverse — Conditions are the same as described for B, with the motor running forward, except that the countervoltage increases in the direction indicated and the other section of the rectifier blocks the current flow through HCP.

This type of rectifier permits some current to flow in the reverse direction and the current increases as the voltage is increased. In selecting the rectifier, current limiting resistors and holdout coil, this must be considered. Assume the motor is running at maximum speed, and the master switch is moved to the off position momentarily and then back to the running position in the same direction. The motor will drift while the master switch is in the off position so when the motor is reconnected to the line the countervoltage will increase rapidly to its maximum value. This high countervoltage is applied to the holdout coil circuit in the direction so current flow will be blocked by the rectifier. Maximum reverse current through the rectifier will be obtained under this condition. Proper selection of material for the holdout coil circuit must be made so the plugging contactor will not fail to close under this condition.

It is sometimes desirable to provide more than one plugging contactor. This is often required on ore bridge or coal bridge trolley drives which have long runs and

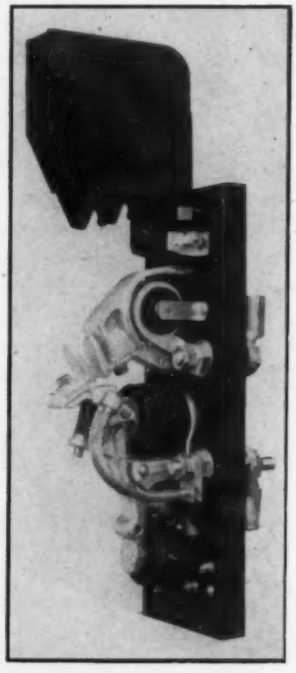


Figure 10 — This plugging contactor has a closing coil and holdout coil assembled in one structure.

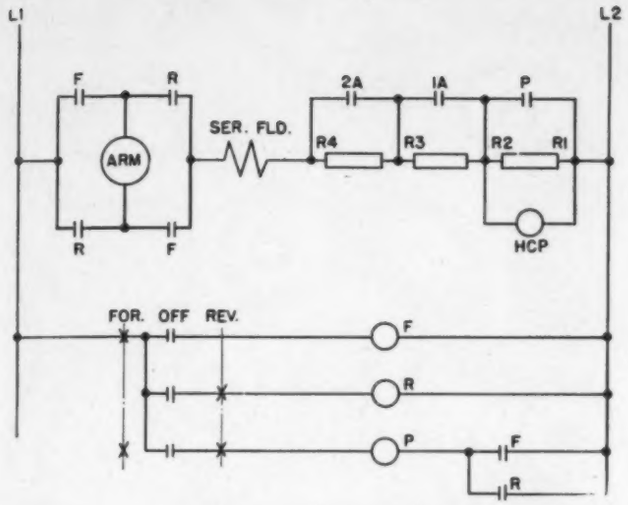


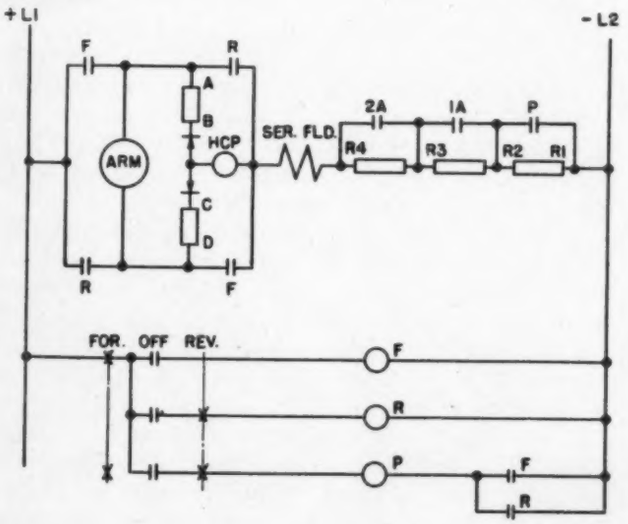
Figure 11 — Diagram of reversing plugging controller with plugging contactor constructed with a closing coil and holdout coil.

where the speed may reach three times rated motor speed. Additional plugging contactors are used to obtain a lower peak current when the motor is plugged and control the rate of deceleration automatically as desired. This results in smoother operation and helps to reduce bucket swing. Rectifier plugging control may be used to advantage where a number of plugging contactors are required.

A method for two plugging contactors is shown in Figure 16. Both plugging contactors are the same type as shown in Figure 10 and their holdout coils are connected the same as for the single plugging contactor with a rectifier. Both holdout coils are the same. Plugging contactor 2P will close just before the motor reverses as described for the single plugging contactor method under Figure 15-D. Contactor coil HC1P is provided with a series resistor EF, so contactor 1P can be adjusted to close at a higher countervoltage depending on the speed it is desired to obtain a second current peak.

When a motor is plugged, especially after it has drift-

Figure 12 — Diagram of reversing rectifier plugging controller.



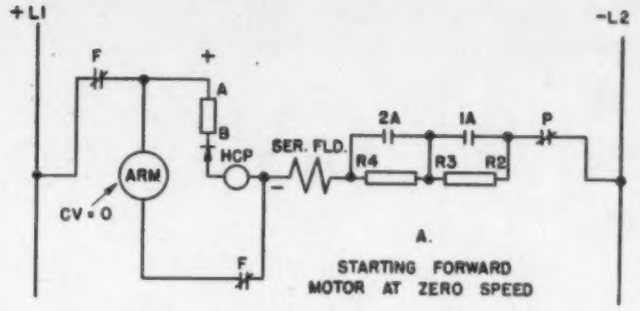


Figure 13 — Operating sequence of reversing rectifier plugging controller, step A.

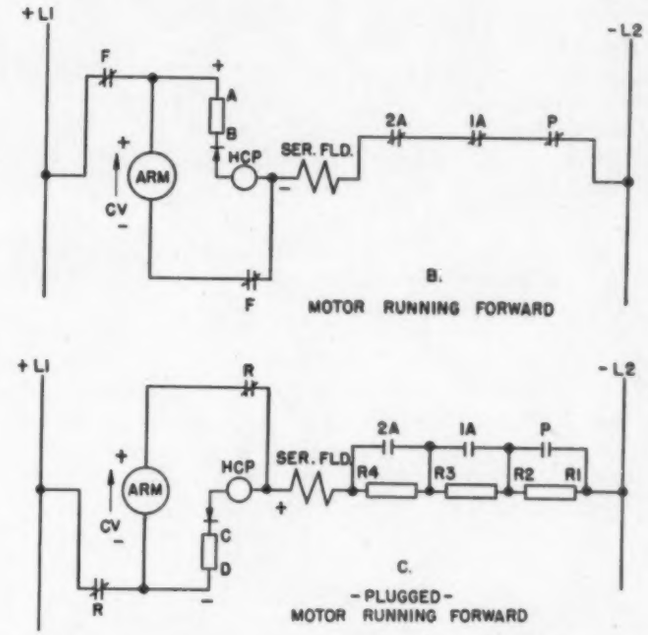
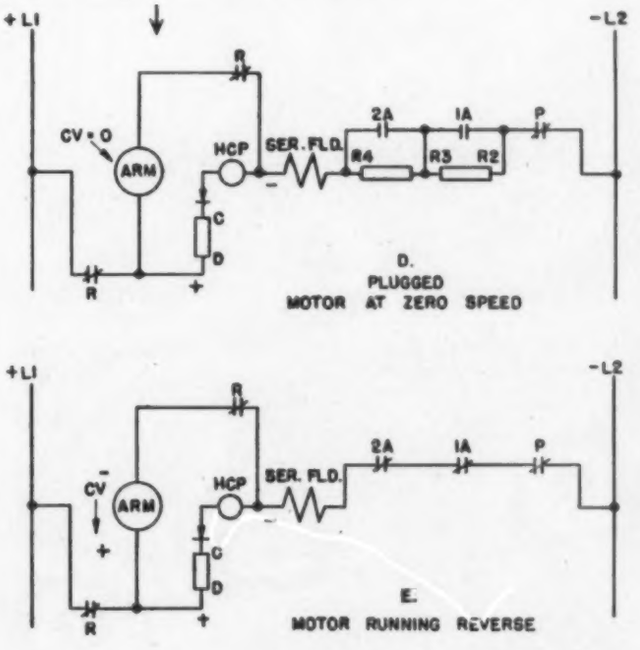


Figure 14 — Operating sequence of reversing rectifier plugging controller, steps B and C.

Figure 15 — Operating sequence of reversing rectifier plugging controller, steps D and E.



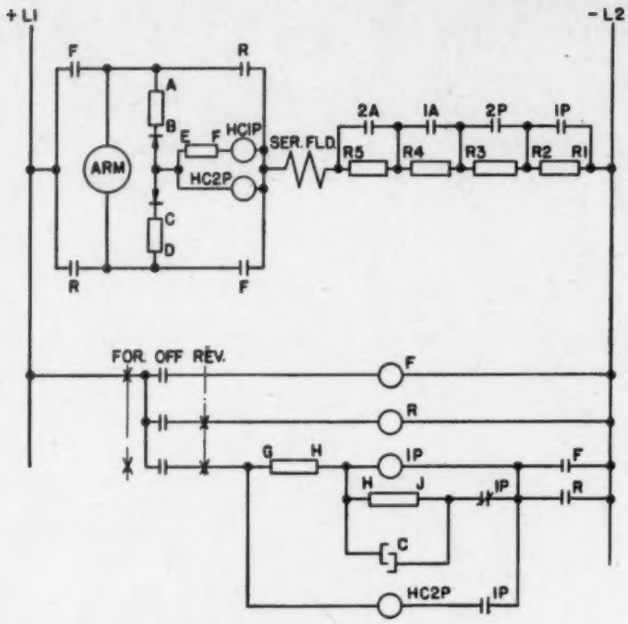
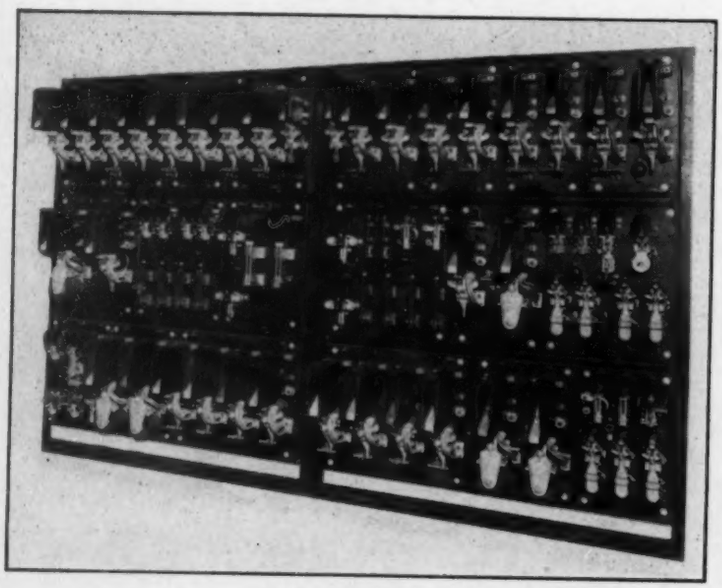


Figure 16 — Diagram of reversing rectifier plugging controller with two plugging contacts.

ed a short time with power removed, the countervoltage does not build up immediately. Since contactor 1P is set to close with a higher voltage across the holdout coil and series resistor than on the single plugging contactor method, more time will be required for the countervoltage to build up to the higher voltage. With standard high speed mill type contactors it is necessary to delay the closing of 1P, until the countervoltage reaches the voltage to lockout 1P.

Contactor 1P may be delayed in closing by connecting a capacitor C in parallel with the closing coil 1P, and resistor GH in series with this parallel circuit as shown in Figure 16. HJ is a discharge resistor for the capacitor; its function is explained later. When this

Figure 17 — A rather elaborate reversing controller used on an ore bridge trolley.



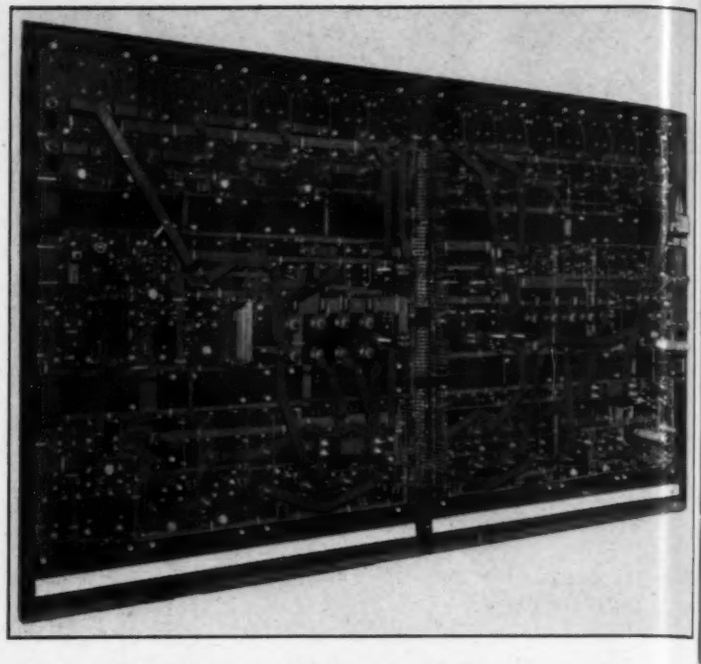


Figure 18 — Little space is occupied by the rectifiers as is illustrated by the back view of the controller panel shown in Figure 17.

circuit is connected to the line through the master switch and one of the directional contactor interlocks, the capacitor will charge with a high initial current. The value of this current will decrease as the capacitor accumulates a charge. The high initial current through resistor GH produces a high voltage drop across this resistor. The difference between this voltage drop and line voltage is impressed across coil 1P. This initial voltage across 1P is not enough to operate the contactor. As the capacitor becomes charged, the voltage drop across GH decreases and the voltage across coil 1P increases. A time delay, depending on the values of resistors and capacitor selected, is thereby obtained before the closing coil of 1P is energized enough to close the contactor. An interlock on 1P opens when the contactor operates to remove voltage from the capacitor. The capacitor then discharges through resistor HJ so it will be ready for the next operation. Disconnecting the capacitor from coil 1P also opens the circuit so contactor 1P will not be delayed in opening when the master switch is moved to the off position.

Figure 17 is a photograph of a two motor ore bridge trolley controller with Wilson Ritchie dynamic braking and three plugging contactors using the rectifier plugging method similar to that just described. This is rather an elaborate reversing controller as it includes many features, which apply three steps of dynamic braking on power failure or when the slowdown limit switches are operated above a preset speed, sets brakes only after the dynamic braking torque has decreased so the wheels will not slide when the brakes are applied, operates the sanders when brakes are set or dynamic braking is applied, and four steps of definite timed acceleration.

A rear view of this controller is shown in Figure 18 to show the small space required by the rectifiers which are used in the plugging control circuit. Two separate rectifiers were used on the controller because of the

current demand for three holdout coils. The positive terminals of the rectifiers are identified with red paint to facilitate correct wiring.

Many of the plugging methods described are familiar circuits because all of them have been employed on standard mill and crane controllers. The rectifier plugging method has recently been applied on a limited number of controllers. The results obtained with one or a number of plugging contactors, using rectifiers with the two coil contactor, indicates reliable and consistent plugging control is possible with a minimum number of operating devices. It is expected this method will be more extensively used in the future.

DISCUSSION

PRESENTED BY

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T. B. MONTGOMERY, Engineer-in-Charge, Control Engineering Section, Electrical Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin

E. J. POSSELT, Supervising Engineer, Cutler-Hammer, Inc., Milwaukee, Wisconsin

E. M. Hays: It is my opinion that a reliable properly designed plugging circuit for coal and ore bridge trolley travel is a most important item in the building of a successful bridge. This circuit must be designed for stopping the travel with the minimum amount of bucket swing, and the plugging contactors must all be closed on zero speed of the travel motor so that accelerating torques required for the fast acceleration of the trolley are available.

It may be of interest to study Figure 19, a graph showing motor deceleration and travel distance for a multiple plugging ore bridge trolley travel circuit. The plugging curve on this graph indicates the trolley travel distance plotted against motor rpm. The trolley travel of this bridge with full loaded bucket reaches an approximate speed of 825 fpm near the end of its cycle travel, equivalent to a motor speed of 880 rpm. This trolley has a two motor drive, each motor, a series wound 230 volt d-c, frame 12, AISE mill type motor having a ½ hour rating of 100 hp at 420 rpm. The torque of this motor is 1250 lb ft for its ½ hour rating. When the motor is plugged at this high motor speed, the total plugging resistance is designed to give a peak plugging torque of 1560 lb ft which is only 125 per cent of the ½ hour rated motor full load torque. The trolley with this plugging torque applied decelerates from a

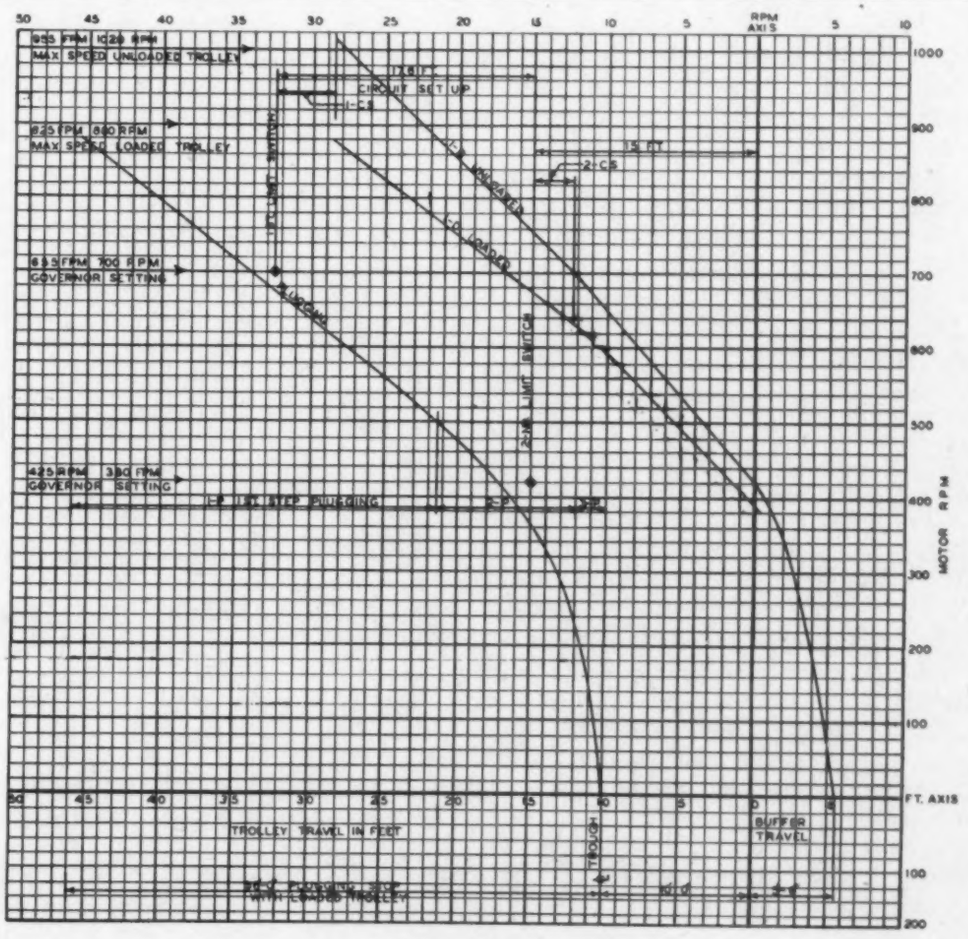

Figure 19 — This graph shows the motor deceleration and travel distance for a multiple plugged ore bridge trolley.

motor rpm of 900 to 500 and the trolley has traveled approximately 25 ft. At this point, the motor plugging torque has reduced to approximately 950 lb ft and the motor countervoltage is approximately 208 volts, at which point the first plugging contactor closes and resistance is cut out of the circuit to bring the plugging torque back up to the peak value of 1560 lb ft. On this plugging step, the trolley motors are decelerated from 500 rpm to approximately 260 rpm and the trolley has traveled in this plugging step about 8 ft. The motor countervoltage at this point is about 85 volts, at which voltage the second plugging contactor closes to cut out the remaining plugging resistances which again provides a motor peak plugging torque of 1560 lb ft. The trolley motors are decelerated from 260 rpm to 0 rpm and the trolley travels approximately 3 ft.

This particular trolley is a four wheel trolley, and when operating even on wet rails the traction is large enough to allow this 1560 lb ft peak torque without skidding the wheels. If one step of plugging was used on this trolley, the peak plugging torque should not be greater than the peak torque value we have used and you can observe that a trolley travel of approximately twice the distance would be required to bring the trolley to a zero speed. This, of course, would result in a longer operating cycle time and reduce the material handling capacity of the bridge. A multiple plugging circuit provides trolley stop in the minimum distance with the minimum of operating time.

The average decelerating rate of this multiple plugging circuit is 3 ft per sec per sec.

The remaining curves on this graph indicate the automatic limit switch slowdown and stop decelerating curves for this bridge.

L. R. Milburn: I have one question on crane bridge control. What protection do we have when we forget to apply the foot brakes but instead we plug the bridge motors for stopping and then the overload relays open?

Another question: Do you believe that the rectifier type of plugging control is superior to the old type of holding coils?

T. B. Montgomery: The circuits illustrating various plugging methods are, in general, familiar and most users have had experience with some one or more of them.

Rectifiers in control circuits with relatively small currents may be supplied oversize with insignificant cost so as to insure very long life; the first ones supplied industrially are still operating. Such use of rectifiers for discriminating circuits has been proven and may be expected to be used in many places as a better solution to special control problems.

E. J. Posselt: The data presented by Mr. Hays emphasizes the importance of using a plugging method which is not affected by variations normally encountered on an ore bridge installation. Fluctuations of the line voltage and normal heating of the motor and resistors will cause changes in the motor plugging torque. If the plugging torque varies because of these conditions, the distance traveled before stopping the trolley will not be the same for each trip. It is desirable to use plugging control which is not affected by these normal variations to keep the stopping distance of a high speed trolley as constant as possible.

Since the rectifier plugging method described in this paper is controlled directly by countervoltage, normal variations of line voltage and heating will not change the operation of the plugging control. These variations will affect the operation of the plugging control in any method in which plugging control is dependent on countervoltage plus line voltage.

This answers Mr. Milburn's last question. The rectifier plugging method is more consistent in operation than the method shown in Figure 11. In Figure 11, the voltage across the holdout coil is dependent on countervoltage plus line voltage. For mill operations the method shown in Figure 11 is considered satisfactory, but for crane service, especially high speed plugging drives, the advantages of rectifier plugging make it the preferred method.

Mr. Milburn also asks what protection can be provided for stopping bridge motors, when the overload relays open and the brakes are not applied. It is necessary to provide dynamic braking which will be automatically applied under these conditions or whenever power failure occurs. On the usual bridge drive using a series type motor, contactors will be required to reconnect the armature and series field so the countervoltage will excite the series field in the proper direction for either direction of armature rotation.

For a single motor drive with a drift point, it is necessary to excite the series field through a teaser field resistor to maintain countervoltage while drifting. This is required to insure that the proper dynamic circuit will be established for dynamic braking after plugging if the motor is plugged after drifting a short time. On a two motor drive the Wilson-Ritchie dynamic braking method may be used. In this method the countervoltage of armature No. 1 causes current to flow through the series field of motor No. 2 and the countervoltage of armature No. 2 causes current to flow through the series field of motor No. 1. The series fields are excited in the proper direction for either direction of travel to provide dynamic braking when the dynamic braking loop is closed. In both methods, the dynamic braking contactor operating coils should be connected so the contacts will close when the overload relays open or when power failure occurs. These two methods are described by Mr. P. B. Harwood in the Association of Iron and Steel Engineers' Proceedings for the year 1945 under the subject of "Unusual Applications of Motor Control."

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IN THIS AND EVERY ISSUE

A Realistic Scrap Policy

. . . . address given at the Spring meeting of the Association of Iron and Steel Engineers, Philadelphia, Pennsylvania, May 26, 1947 . . . .

By ROBERT W. WOLCOTT

President, Lukens Steel Company, Coatesville, Pennsylvania

▲ FIVE YEARS ago, we were embarked on a program of finding sufficient plowshares to beat or forge into instruments of war. Today we are attempting to get back those instruments of war to make into plowshares and the many other end uses of iron and steel for a nation at peace.

During the past five years, a lot of water has passed under the bridge. Great strides have been made in engineering and science, in methods and techniques, in manufacturing and production, new inventions and new ideas. The Association of Iron and Steel Engineers has played a major part in the steel industry's contribution to this improved industrial world.

If statesmanship and diplomacy could only keep abreast of our strides in engineering, science and technology, what a different world it would be. Our prayer should be: "God grant us knowledge and understanding to bring this about."

When I was asked to speak to you on the subject of scrap and I endeavored to outline what I should say, I was at first confused and the more I thought about the subject the more indignant I became at the utter stupidity of our great nation in the handling of a relatively simple problem having to do with the conservation of what might be termed the by-product of a natural resource which God has given us, and around which we have built up the greatest industrial empire in the world.

Why in the world should we, the steel industry, have to beg and implore our government to return to our shores, that little which remains of a most important metallic which we exported from this country during the 1930s and the war years, is most difficult for me to understand or comprehend. Especially is this so when it is recalled that we urged that it not be exported in the 1930s, and none of us have to recall this fact, because the Japanese particularly saw to it that it was seared in our souls. We are asking to have returned to our shores what had been our peacetime scrap, the obsolescence of a thriving and healthy country, which wanted nothing so much in this world as peace. This peacetime scrap had been forged and manufactured into guns and instruments of war by our enemies and is now stained with the blood of our youth.

It will always be an enigma to me, and certainly history so far has not cleared it up, as to why the State Department insisted and continued on its policy of appeasement of Japan and Germany in the late 1930s and early 1940s, and I note through press releases there are indications that they are about to repeat another appeasement program in dealing with Russia. This appeasement policy was consistently followed in face of repeated warnings and testimony that the scrap material which we were exporting was being turned into implements of war to be used against us in the then not too distant future; that it was rapidly depleting one of our important sources of metallics; that over the period of 16 years, namely, from 1923 to 1939, we had decreased, through our own use and through export, our reservoir of scrap by a figure approaching 40 million tons. There were many other good and valid bases of warnings set forth, not the least of which was that we were going to feel the effects of this exporting of scrap from an economic viewpoint for many years to come.

However, our pleadings and warnings were to no avail until our enemies had fully demonstrated that our warnings were not hysterical fears and that industry's motives were not selfish as was the accusation of those benefiting through this export trade. To paraphrase a familiar quotation, "the door was closed but the mankiller was gone with his weapons of destruction which we had made possible for him to manufacture."

It may seem to some of you that I am unnecessarily dwelling on a situation which is now history and the sooner forgotten the better. However, I do not believe that we can do this. We cannot ever forget the lessons of the past, and today we are still knocking at the door of the Government that once turned a deaf ear to our pleas to remember that with scrap we are dealing with an important source of metallics which is vitally necessary to our national economy and our protection in a not too-stable world.

There is still one other lesson that I think came out of our early efforts to keep our scrap material in this country. It is the testimony of a colonel of the army, a member of the Army and Navy Munitions Board who was then embarked on a study and plan for what was known as the "M-Day" or "All-Out Program." Remember, this was in February, 1940, less than a year from the declaration of war by England on Germany, and less than two years before the fateful date of December 7, 1941. This officer testified before the Committee on Military Affairs, House of Representatives, on a "Bill to Provide for the Protection and Preservation of Domestic Sources of Iron and Steel," and I quote from his testimony:

"When we consider the total ingot capacity of this country, some 65,000,000 or 70,000,000 tons, and that the possible requirements of the armed forces would be something like one-fifth or one-sixth of this capacity to

produce steel, we cannot get very much alarmed when there is such a large margin of additional capacity over what the defense forces will need in the event of a major emergency."

In other words the army and navy would only require between 11,000,000 and 14,000,000 tons of our ingot capacity for an all-out war in which we later found ourselves involved. I bring this point out only to warn you that we in the steel industry must be on our guard. We live in a democracy, and we find here at this prewar period not only an apathetic public and a government not willing to be realistic in their efforts to avert war, but the men to whom we looked to be abreast of our requirements for the protection of our country, failing to appreciate the requirements of their own job and an unwillingness to heed the warnings, or at least to probe into and study the facts and findings of those whose business it is to operate and plan for the world's greatest industry, the steel industry.

Enough for the past except to have each of you recall in your own mind our experiences in obtaining sufficient scrap during the war period. For the first time the public and the government became conscious that scrap is not a waste product but an important item of our natural resources.

The events of the last six months, where we find another critical shortage of this material, and a skyrocketing of prices beyond anything heretofore known, did not come as a shock to either your officials or to your purchasing agents.

Since the close of the war and the end of controls, the Scrap Committee of the American Iron and Steel Institute has been endeavoring to find ways and means of counteracting what is now a reality and which we knew would come to pass, namely, a shortage. Our only error may have been in the degree of price increase which has resulted from the shortage. The trend of the nation's inventory, that is the stock in the hands of the dealers and the consumers, has been steadily downward since the injection which was given to our stockpiles by the scrap drive during the war. Today we find the national inventory many tons below the point at which we found it necessary to have a nationwide scrap drive in 1942 in order to maintain production for the "arsenal of democracy." Some of the factors which led us to the conclusion of more than two years ago that a critical shortage was imminent were:

1. That not sufficient time had elapsed to implement the stock of scrap, farm and country scrap, since our all-out drive in 1942.
2. That the percentage of production scrap from the processing industry, the fabricator and manufacturer, would be a great deal less than it was during the war period due to the type of end products being produced. As an example, shells in the finished state required only 20 per cent of the ingot, and the remainder ultimately came back to the mill as scrap, mostly in the form of turnings.
3. The breakdown of the collecting system of farm and country scrap. The junkman was working in the factory where he could make more money. Trucks were not available to haul the scrap.
4. The shortage of new and replacement parts for machinery and equipment brought about a reluctance on the part of the manufacturer, the farmer, the automobile junk yard, and the transportation systems to sell anything which might possibly be used to mend or repair existent equipment.

The only possible sources beyond the normal flow of production and country scrap to counteract what we saw coming, in order of their then immediate availability, were:

1. Battlefield scrap in the European theatre of operations.
2. Scrapping of certain types of surplus materials and equipment not otherwise usable or salable.
3. Scrapping surplus merchant marine and naval vessels and equipment.
4. Battlefield and naval equipment scrap in the Pacific Islands.

In October, 1945, acting in compliance with General Somervell's request, a commission of experts after an intensive inspection trip, recommended that all iron and steel scrap in the European theatre of operations under American control be returned to this country at the earliest date possible. This report was in turn referred by the army to the Office of War Mobilization and Reconversion in order to determine the over-all government policy.

The recommendations of the commission appointed by General Somervell were turned down without any one of the personnel of the commission being given an opportunity to be heard or questioned on the reasons for their recommendations. Neither were there present at this joint meeting of O.W.M.R. and other government agencies, the representatives of General Somervell who had accompanied the mission to Europe and who were fully acquainted with the whys and wherefores of the recommendations.

Shortly thereafter, the Committee on Scrap of the American Iron and Steel Institute employed the services of L. D. Greene, who for many years was responsible for Bethlehem Steel Company's scrap purchases, and who had recently retired. Mr. Greene spent many months in Washington attempting to educate the agencies responsible for the four possible sources enumerated above as to the needs of immediate action in returning the scrap to this country. However, as usual, there being no immediate crisis, it was not possible to get much more than a sympathetic ear and a promise to do what was possible in unwinding the red tape that would lead to action. Two important results did come out of these months of walking the streets of Washington:

1. The O.W.M.R. reversed their decisions to the suggestions of the Overseas Scrap Committee to allow the return of battlefield scrap to the United States, and further ruled, after a certain portion of scrap from occupied Germany had been sold to foreign countries, that scrap in the occupied zone could only be sold to a purchaser who would agree to return the scrap to the United States. It should be pointed out, however, that in the meantime, all of the scrap in France, Belgium, Holland, England and Italy belonging to the United States, as well as the scrap in the Philippine and Caroline Islands, was sold to those respective countries along with other surplus material. This amounted to many hundreds of thousands of tons of a vital raw material.

2. Mr. Greene was very helpful in expediting the sale of surplus ships owned by both the Maritime Commission and the navy, as well as the lease of government facilities to private interests for breaking up or scrapping of these vessels.

It was now decided by the Scrap Committee of the American Iron and Steel Institute that no further benefits would result at that time in keeping Mr. Greene in Washington and his services were discontinued. Shortly thereafter, O.P.A. controls were discontinued, and the general economic condition of the country became more stable with a slowly increasing rate of operation of the steel industry and an increase in demand for scrap. Prices within a short period of time sky-rocketed and all available stocks, both in dealers yards and at the mills literally melted away. Open hearth furnaces were down due to a lack of scrap. On top of acute shortages, the government became intensely interested in the shortage of finished steel for homes and freight cars. This resulted in allocating merchant pig iron to the foundries for soil pipe and other requirements of the housing program, superimposing over a hundred per cent increase in requirements for steel for railroad cars, as compared with what was then on the books of the steel companies for this end use.

This action on the part of the government gave the industry another opportunity to stress with the responsible agencies in Washington the acute scrap shortage and the impossibility of fulfilling the government-backed programs unless immediate steps were taken along the lines of the program already mentioned. Mr. John Steelman, now assistant to the President of the United States, called a conference of certain government agencies and stated that an additional 500,000 tons would move into the market by May 1st, and that 1,650,000 tons would come from the sources mentioned before the end of the year.

Again the Scrap Committee of the American Iron and Steel Institute obtained the services of Mr. Greene to cooperate and, where necessary, coordinate the activities of government and industry in this renewed attempt to obtain a larger flow of scrap to the mills.

Simultaneously it was decided to organize all of the parties interested in the scrap situation into a single joint committee. This move would save duplication of effort, give greater prestige and coverage, and would assure a united backing to any future plans. This committee is composed of three members from the steel industry, three members of the scrap industry and three members of the foundry industry.

The basic plans of this committee are:

1. Expedite the movement of obsolete and single-purpose tools (which have no usable peacetime value) into the market.
2. These obsolete and single-purpose tools made up the major portion of the 500,000 tons of scrap which Mr. Steelman on March 7 stated would be released within two months. As far as we can determine, only a few thousand of these 500,000 tons have been released as of this date. This is in spite of conferences and promises without number from the W.A.A. that we could expect full compliance with Mr. Steelman's statement.

It is perfectly apparent, as in so many other cases within the government, that the liquidation of W.A.A. will be prolonged as far into the future as possible in order to save jobs. This little game is costing the people of the United States a minimum of $3,000,000.00 per month.

The next of importance in the plans of the committee is the matter of getting the army and navy to determine how much of their equipment it is worthwhile keeping and maintaining for future use and how much should now be demilitarized and sold as scrap. This equipment consists of ships and armament of all kinds.

The committee also hopes to have legislation enacted which would allow the army and navy to recapture through the sale of scrap their costs incident to demilitarizing, preparing and transporting of this military equipment. Under present regulations, the monies received by the army and navy from the sale of such scrap go directly to the treasury and the costs of demilitarization is a debit against an already reduced budget of these agencies.

Ten years of my own time and nearly a year of the time of Mr. Greene in Washington haxe g.ven us a thorough and complete education on the practice of "passing the buck!" We have been indoctrinated by experts. We, therefore, feel that the only hope for results is to have legislation enacted which will place the responsibility for the conservation of scrap in the lap of one of the governmental bureaus. It is hoped that Congress will grant broad powers to this bureau so that through acquisition and conservation methods our dwindling stockpile may be built up to an adequate basis.

It is likewise felt that a large educational job must be done if we are to have public approval and cooperation in such a conservation move. Therefore, the committee will employ the services of someone to make a study and report of:

1. The effect of exports and loss of potential scrap through the prosecution of a world war in Europe and the Pacific Islands.
2. The trend of obsolescence of scrap potentials in this country, such as buildings, bridges, equipment, etc.
3. The future requirements for scrap and its relation to our whole problem of metallics, especially iron ore.

So you see we have quite a broad program before us, which for simplicity we will put into two projects:

1. The education of our people and especially our legislators that scrap is not a waste product and is not unlimitable.
2. A real conservation program as the responsibility of our government.

The Association of Iron and Steel Engineers is a most important segment of this great industry and in my opinion can be of tremendous help in educating the public and our governmental officials to the seriousness of the problems of scrap supply as it relates to whole problem of metallics.

We cannot go on blindly hoping that a miracle will provide the wherewithal to pull us out of our predicaments in times of emergency.

We must educate, we must plan and we must conserve. If we carry out these three precepts fully, it may be possible for us to rebuild our national inventory sufficiently to meet the demand on our industry for a national emergency or for a long peaceful era, and may God give us the wisdom and strength to bring about the latter.

WEIRTON BUILDS HIGH SPEED COLD MILL

▲ THE start of operations of the new No. 6 cold mill at Weirton Steel Company represents still another step in the development of sheet and tin-plate production. Most noteworthy feature of the new mill is the unprecedented delivery speed of 5000 fpm, which is about one-third higher than the speed of any previous mill and doubles that of the majority. Six years ago, when "The Modern Strip Mill" was published by the Association of Iron and Steel Engineers, only five cold strip mills had delivery speeds exceeding 2000 fpm. One of these had ventured up to 3750 fpm. Subsequent development to the present "mile-a-minute" unit is a tribute to the engineering efforts and vision of steel plant engineers and operators, mill builders, and electrical equipment manufacturers.

Although the new unit can roll sheet gages, it will be used primarily for the production of tin plate. The mill is capable of rolling hot rolled, pickled strip up to 38 in. wide and 0.093 in. thick, down to 0.008 in. or less, at speeds up to 5000 fpm. Finished coils will be 16½ in. inside diameter and up to 66 in. outside diameter, and will weigh up to 30,000 lb.

At the entry end of the mill is a motor-driven slat-type conveyor 33 ft long, on which incoming coils are placed by crane. The conveyor delivers the coils to a sloping ramp which leads to a coil box equipped with cradle rolls, rotating side guards and stripper roll. The end of each strip is fed manually into the first stand of the mill.

The mill is a five-stand tandem mill, with four-high

Figure 1 — General view of entry end of Weirton Steel Company's new No. 6 tandem cold mill.

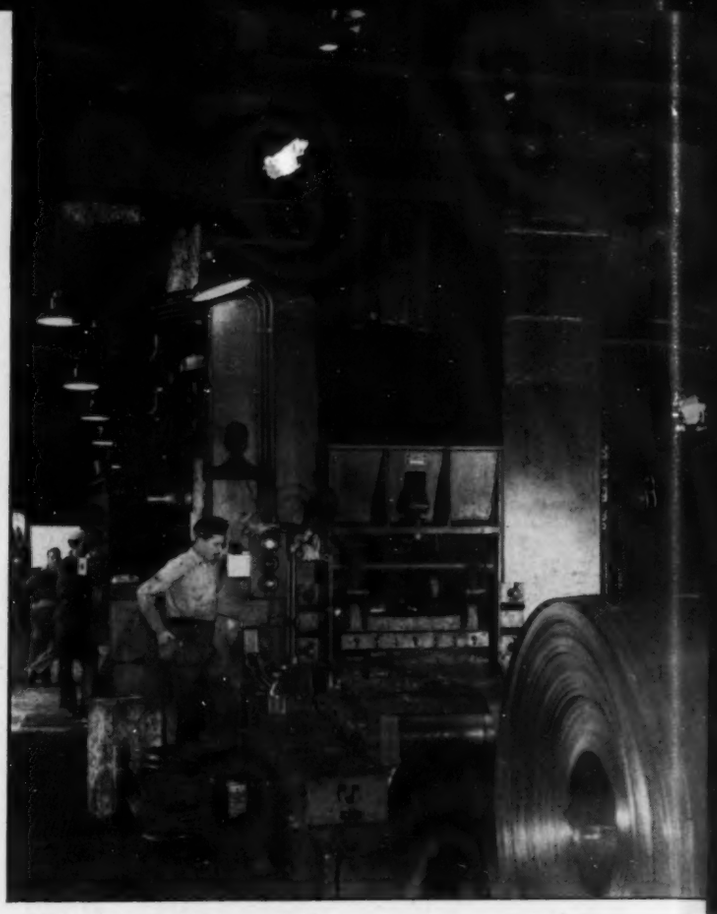

Figure 2 — Detailed view of entry end of new mill which went in operation on May 13, 1947.

stands carrying work rolls 21 in. in diameter × 42 in. body length, and back-up rolls 53 in. in diameter × 41 in. body length. Work rolls run in four-row tapered roller bearings, while back-up rolls are mounted in oil film bearings. Top rolls are balanced by hydraulic cylinders located in the bottom chocks. This hydraulic system operates under a pressure of 2000 psi, and contains a weighted accumulator. Mill housings are of heavy construction, with 29 in. × 30 in. posts, and weigh 104 tons each.

Mill screws are driven by two 150 hp mill type motors through double reduction spur gearing and worm gearing with an over-all gear ratio of 800:1.

Some unusual features are incorporated in the drives for this mill. The first three stands are driven by single motors connected through pinions to the work rolls, without any reduction gears. Stands No. 4 and 5, however, are operated by twin motor drives connected to the rolls by speed-up gear sets. Characteristics

Drive Characteristics

Stand	Motor hp	Motor rpm	Gear ratio	Roll rpm	Mill speed fpm
1	1750	70-210	Direct	70-210	385-1150
2	3500	125-312.5	Direct	125-312.5	690-1725
3	*3500	225-450	Direct	225-450	1240-2480
4	(2) 1750	225-450	0.645	348-696	1920-3840
5	(2) 2250	250-450	0.5	500-900	2750-4950

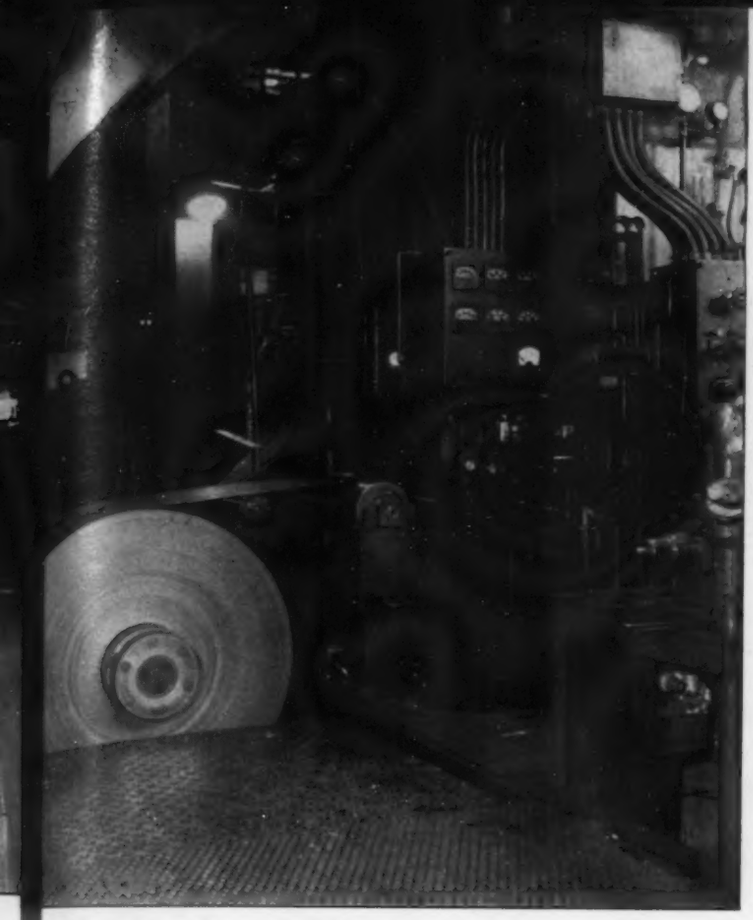

Figure 3 — Tension reel on delivery end of new mill.

of the drives are given in the accompanying table. All of the motors are rated at 750 volts.

These motors operate on adjustable voltage control, with IR drop compensating control and demagnetizing controllers, and are designed with due consideration for the inertia of all rotating parts of the mill and drive, so that constant speed relations between the various stands are maintained at all speeds from threading to running. Thus, tension of the strip between stands is maintained through acceleration and deceleration.

The mill is capable of accelerating from a threading speed of about 500 fpm to a rolling speed of 4000 fpm in 9 sec, while the mill can be stopped from a running speed of 5000 fpm in about 4 sec. Deceleration is increased by the use of a field forcing exciter to lower generator voltage rapidly.

Power for the drive motors is provided by two motor-generator sets, each composed of two 3500 kw, 750 volt d-c generators driven by a 9900 hp, 6600 volt motor. An eleven-unit set, driven by a 1500 hp motor, contains exciter and booster units.

The use of twin drives on tandem cold mills, with each work roll individually driven by a motor, is a new application that is being made on several of the new cold mills now under construction. The principle of synchronization of the two motors, and of division of load between them, is similar to that used in blooming and plate mills to which this arrangement has been applied.

Each speed-up gear set consists of two individual gear sets on horizontal centers, one placed 20½ in. above the other. This arrangement saves floor space, and reduces coupling and shaft lengths, thus reduces WR^2 for the revolving elements. The gears are double helical type, and roller bearings are used throughout.

Following the last mill stand is a 16½ in. diameter automatic expanding and collapsing tension reel. A bell mouth guide leads the front end of the strip to a belt wrapper which remains in position until two or three wraps are made on the drum. Both guide and belt wrapper are then withdrawn, and the mill is accelerated to rolling speed.

Upon completion of each coil the drum is collapsed and stripped of the coil, which is lifted to floor level by an elevator carriage. The coil is weighed and banded, and then removed by overhead crane or truck.

Indicating tensiometers are installed between each two mill stands, while a regulating tensiometer auto matically holds constant tension between the last stand and the tension reel

Three 1000 psi direct-pumping hydraulic systems are installed, serving the uncoiler and roll-changing rig, the reel stripper, and stops for the coil ramps.

Two circulating oil systems are installed to supply oil to the oil film bearings of the back-up rolls, one for stands 1 and 2 and one for stands 3, 4 and 5. Each system is complete with tanks, filters, cooler, temperature control, gages, thermometers and alarms. Two similar circulating systems supply pinion stands, gear drives and mill screw-downs. Grease lubrication is provided where needed by two motor-operated centralized pressure systems, two manually operated systems, and by various individual fittings for hand lubrication.

Palm oil, supplied from a system containing the usual pumps, coolers, etc., is used to lubricate and cool the strip as it passes through the mill. The oil is applied to both top and bottom of the strip.

This mill has a nominal rating of 600,000 net tons of tin plate per year, although at its maximum running speed, approximately 2½ tons of strip will flow from the mill each minute. The installation is expected to increase Weirton's tin-plate capacity by 50 per cent.

Figure 4 — These are the two 1750 hp motors for stand No. 4.

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Granite City, Illinois

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Youngstown District Works
Carnegie-Illinois Steel Corporation
Youngstown, Ohio

WALTER L. DOUGLASS
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Lukens Steel Company
Coatesville, Pennsylvania

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Birmingham, Alabama

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(Assistant Mechanic) Maintenance Dept.
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Duquesne, Pennsylvania

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Fairfield Open Hearth
Fairfield, Alabama

RENE FIEVET
Chief Engineer
Societe Francaise de Constructions
Mechaniques anc. ets. Cail
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Wickwire Spencer Division
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Alan Wood Steel Company
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Thomas Steel Company
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CHARLES E. GENOVESE
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Chicago, Illinois

EUGENE J. GÉRARD
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Rotary Electric Steel Company
Detroit, Michigan

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Depto de Hornos Altos
Apartado Num. 206
Monterrey, N. L., Mexico

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Hamilton, Ontario, Cadada

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Sheffield Steel Corporation
Sheffield Station
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Bethlehem, Pennsylvania

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Mechanical Department
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COLIN N. HAMMILL
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Hamilton, Ontario, Canada

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Let CONTINENTAL Engineers work with you in 1947 and every year.

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CHICAGO • PITTSBURGH

Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.

YES! your logical source for
ROLLING MILLS • STEEL PLANT EQUIPMENT and SPECIAL MACHINERY

✓ *check list*

- ☐ Blooming Mills
- ☐ Structural Mills
- ☐ Bar Mills
- ☐ Billet Mills
- ☐ Merchant Mills
- ☐ Plate Mills
- ☐ Slabbing Mills
- ☐ Universal Mills
- ☐ Hot Strip Mills
- ☐ Cold Strip Mills
- ☐ Continuous Tube Mills
- ☐ Sheet Mills
- ☐ Tin Mills
- ☐ Non-Ferrous Mills
- ☐ Continuous Mills
- ☐ Tables (main mill, delivery, transfer, etc.)
- ☐ Straighteners (all types)
- ☐ Shears (all types)
- ☐ Roll Lathes
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- ☐ Ingot Buggies
- ☐ Drives
- ☐ Saws
- ☐ Conveyors (crop, billet, slab, etc.)

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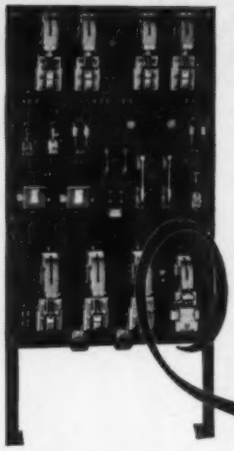
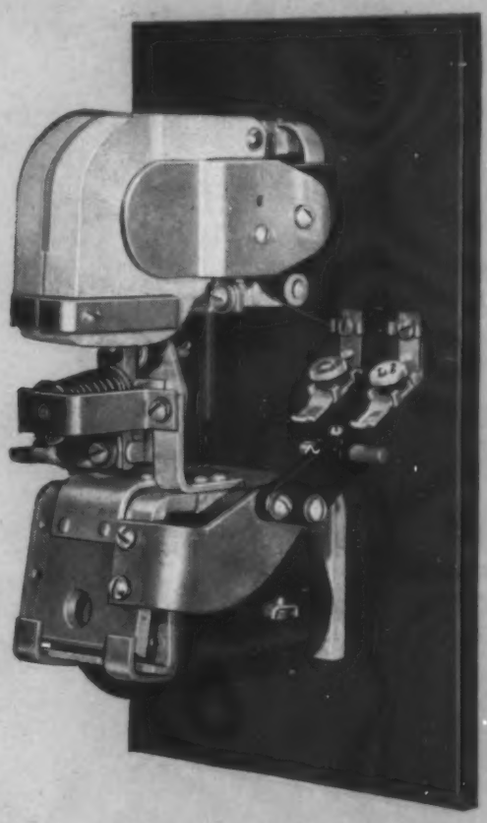
Industry's headquarters for
Rolling Mills and Equipment
Iron and Steel Rolls
Carbon and Alloy Steel Castings

SQUARE D MILL CONTROL HAS *SPRING-CLOSED Contactors* FOR DYNAMIC BRAKING



Braking is needed for close control of normal machine motion, and for safety in event of emergency. Failure in either instance would be costly. Use of a spring-closed instead of a magnetically-closed contactor to complete dynamic braking circuit provides positive action under all conditions of operation.

At left
CLASS 7951 Reversing Dynamic Braking Control for Steel Mill Auxiliaries



SQUARE D's DESIGN OFFERS:

- **Large magnet with booster pickup circuit for quick response over a wide voltage range.**
- **Heavy copper contacts with pronounced wiping action for minimum maintenance.**
- **Strong blowout coils and effective arc barriers for high rupturing capacity.**
- **Frictionless knife-edge bearings for long life.**
- **Continuous (8 hour) ratings of 25, 50, 100, 150 and 300 amperes.**

SQUARE D builds a complete line of Mill Duty Contactors in normally-open as well as spring-closed contactors, including 25 and 50 ampere sizes. These together with heavy duty control relays, overload relays and other components make up the HEAVY DUTY D. C. MILL CONTROL line.

Write for information on CLASS 7950 SERIES Heavy Duty D.C. Control for cranes and mill auxiliaries and CLASS 9003 Master Switches. SQUARE D COMPANY, 4041 North Richards Street, Milwaukee 12, Wisconsin.

6 N. O. CONTACTOR SIZES . . . 25, 50, 100, 150, 300, 600 AMPERES

25 Amperes

50 Amperes

100 Amperes

150 Amperes

300 Amperes

600 Amperes

SQUARE D COMPANY

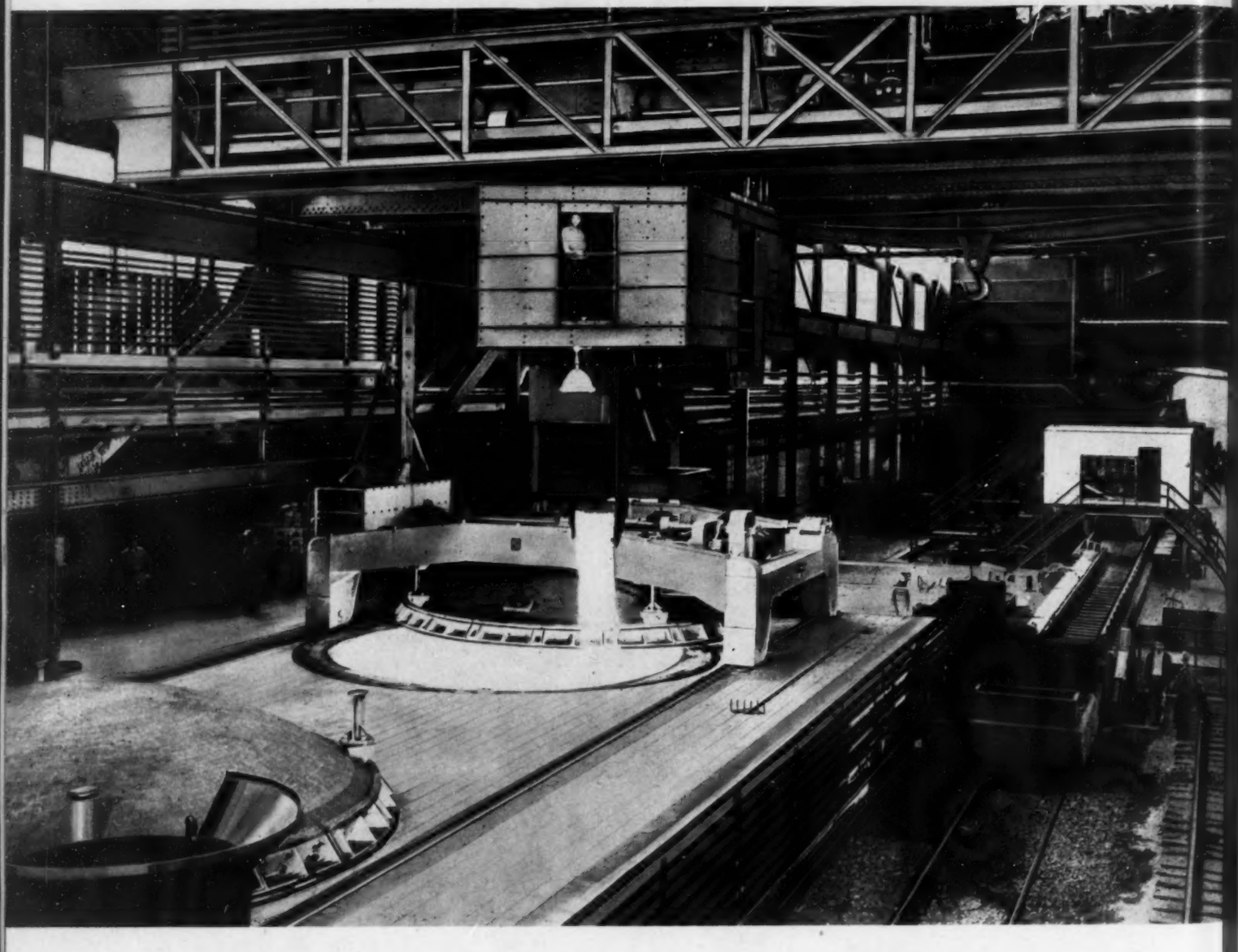
DETROIT · MILWAUKEE · LOS ANGELES

SQUARE D CANADA, LTD., TORONTO, ONTARIO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.

Visit us at the MACHINE TOOL SHOW (Chicago) September 17-26 Booth 678

BUILT BY MORGAN Engineering

MORGAN 7½-TON, 81′3″ SPAN SOAKING PIT CRANE



Illustrated is a Morgan 7½-Ton, 6-Motor, 81′3″ Span, Stiff Leg Type Soaking Pit Crane. It serves a Morgan 36″ Two-High Blooming Mill which was furnished complete with auxiliary equipment. It is equipped with fabricated welded trolley and bridge trucks. Morgan Pit Cranes are provided with spur or worm gear operated trolleys and sleeve or anti-friction bearings as required.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

NEWS SUPPLEMENT JULY, 1947

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

CRUCIBLE STEEL COMPANY COMPLETES FIRST PROJECT IN EXPANSION PROGRAM

▲ Marking the completion of the first large project in the $30,000,000 expansion and improvement program of the Crucible Steel Company of America, executives and plant managers of Crucible Steel toured the company's new spring works in Pittsburgh on June 17, 1947.

Now one of the country's most modern plants for the manufacture of heavy-duty coil and elliptical springs, the Crucible Steel spring works supplies thousands of different sizes and shapes of springs to railroads direct, to car and locomotive manufacturers, and to builders of special heavy equipment.

Its products include the big elliptical springs, some of them with over 20 plates of steel, that are tested at weights of tens of thousands of pounds, 50 per cent more than their prescribed weight load.

Crucible Steel also is the manufacturer of a 51-inch high coil spring made of thick silicon-manganese steel bars which go into the coupling mechanisms of freight cars. Many types of coil springs are built, some of which are "nested" in larger coils in spring assemblies for freight and passenger cars. Special elliptical and coil springs are produced for the newest railroad rolling stock of U. S. manufacturers, and for export. Some 300 persons are employed in the Crucible Spring Works.

Automatic machinery and special processes have been adapted to spring manufacture in the new plant.

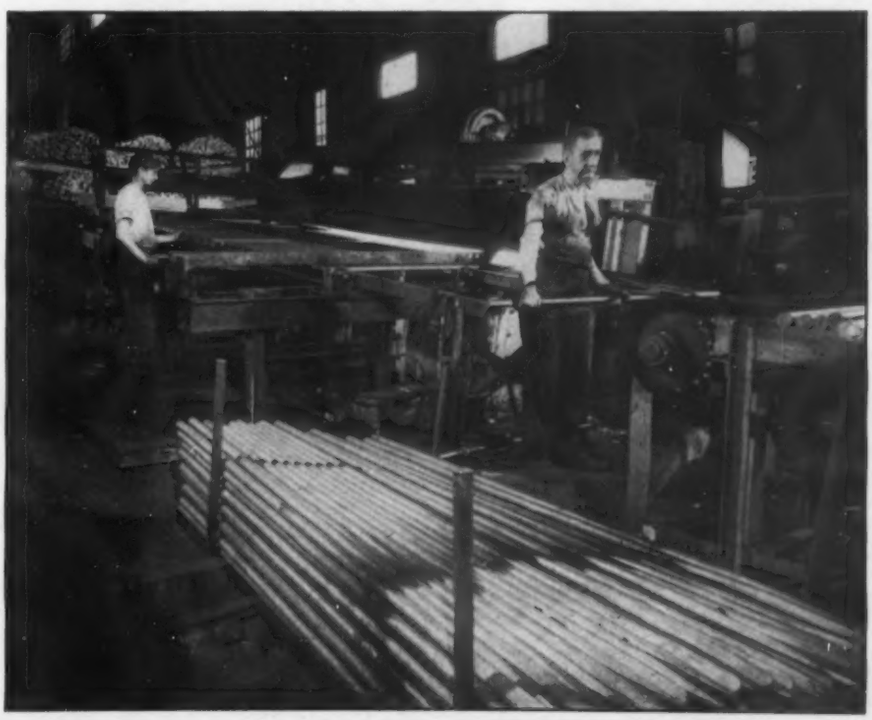
In the coil spring departments, bars of steel are heated and tapered on both ends, then put through the coiling machine where the bars are wrapped around a mandrel into the coil form. After cooling, the coils are again heat treated, quenched in oil, and conveyed through a tempering furnace. Finally, when cold, the springs were tested "solid," compressed under hydraulic pressure. Variations of this process produce other types of coil springs.

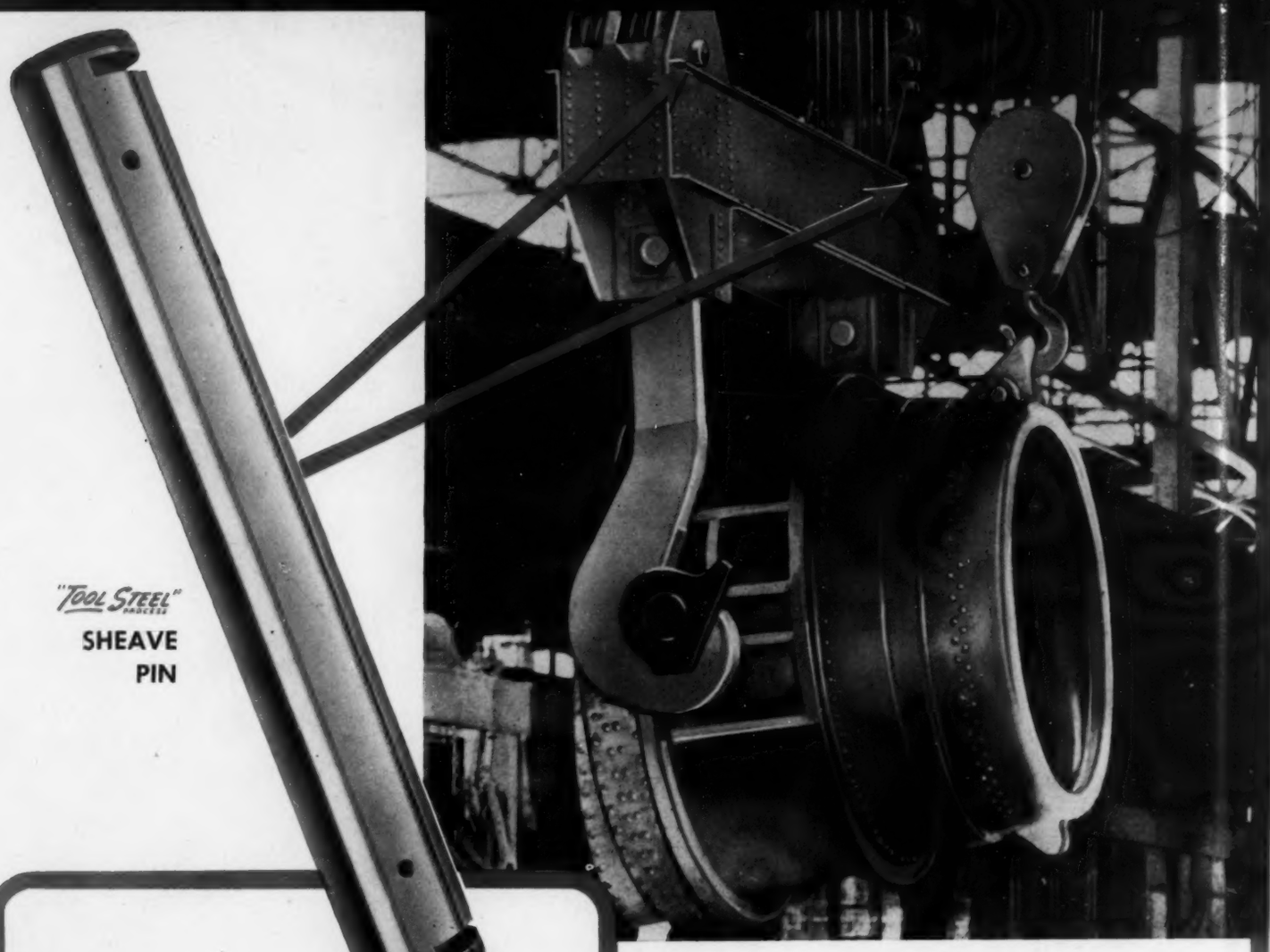
In the elliptical spring departments, machines shear steel strips into matched plates. A great variety of elliptical assemblies also received special heat treatments. Each leaf is centered and the assembly is never separated through the remainder of the process. After being fitted, a step in which some of the plates are slightly arched, the ellipticals are banded, where red-hot steel bands are put in place by presses. Each spring is tested in accordance with specifications of railroad groups and manufacturers.

Until May, 1947, Crucible Steel spring operations also were carried on in the McKees Rocks plant where the Company's spring making activities began in 1909. Mr. O'Donnell has been manager of all Crucible spring manufacturing since that time. Under his direction, the McKees Rocks plant produced some 532,000,000 pounds of springs, a total of several billions of coil and elliptical springs.

The new Spring works was acquired in 1945. The McKees Rocks

White hot at the tips, steel bars are prepared for coil spring manufacturing in the Crucible Steel spring works by tapering. Workers are shown putting bars through the "tip" furnace with a mechanical feed and the tapering roll. Tapered ends of bars (shown in pile in foreground) fit coiling machines.





"TOOL STEEL" PROCESS
SHEAVE PIN

"Bushed" BUSHINGS are few and far between with "TOOL STEEL" PROCESS sheave pins

Product . . . . "Tool Steel" process sheave pins in service on hot metal mixer cranes as shown above.

Plant . . . . . In use by one of the world's largest steel companies. Name on request.

Service Record installed June 27, 1941 and replaced October 14, 1946, after handling 3,535,198 tons. During this period sheave wheels and bushings were changed only twice!

Comments . . . "Tool Steel" pins showed a tonnage superiority of 13 to 1 over ordinary heat-treated pins which were used previously. Competitive pins lasted five months, completely wore out their bushings, and handled only 272,614 tons! This is another example of "Tool Steel's" superiority!

Changing bushings is an expensive, time-consuming operation, but there is something you can do about it!

Specify "Tool Steel" sheave pins and your maintenance is materially and immediately reduced.

Here's why! The surface of "Tool Steel" pins tests from 85 to 90 scleroscope (635-700 Brinell), deep enough for the life of the pins. This guarantees a true surface even under the most severe operating conditions and prevents unnecessary wear on bushings.

The costs are comparable to ordinary pins, but your savings with "Tool Steel" are substantial. Write today for complete information.

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI 16, OHIO

plant was kept in operation during the two-year period of consolidation and modernization which today is completed in all major details. The spring works has a capacity of some 3000 tons of springs per month.

The six other plants of the company, in Midland and Pittsburgh, Pennsylvania; Jersey City and Harrison, New Jersey; and Syracuse, are also engaged in extensive activities of plant improvement and expansion of production facilities.

New equipment and facilities for a greater variety of steel products are being constructed at the Park Works in Pittsburgh, and at Midland where open hearth, as well as electric steels, are made and finished.

At Midland, new billet and bar mills are about half way toward completion. New rolling mills for alloy and stainless steel sheets and strip products are being added. The LaBelle agricultural steel division is already operating partially in its new building.

In Syracuse, the manufacturing facilities for the Halcomb and Sanderson steels for tools and other special purposes are being consolidated in one plant, with many new manufacturing sections. At Harrison, New Jersey, quarters are being made ready for the move of the Spaulding and Jennings Works to a plant built in wartime.

New research laboratories are planned and new warehouses in Chicago and Philadelphia, have been built in a general improvement program throughout the company's production, warehousing, and raw materials departments.

SEPARATOR FIRM MOVES TO NEW MILWAUKEE PLANT

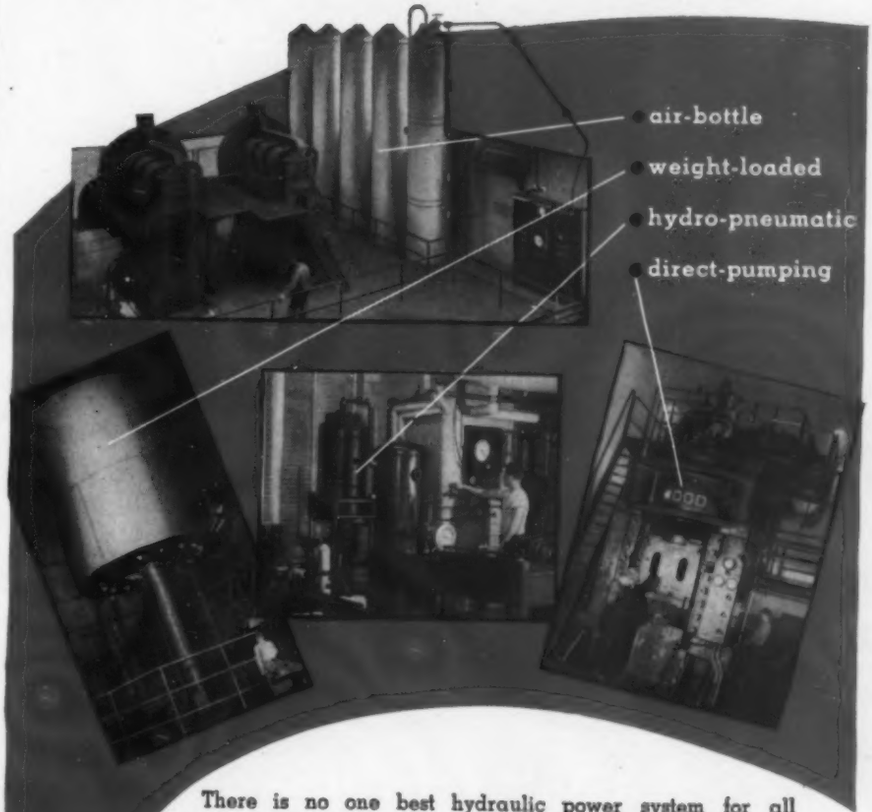
▲ The first company to make magnetic separators practical for industrial uses has crowned forty-seven years of achievement in magnetic engineering and manufacturing with a recent move into a new plant in Milwaukee's southwestern industrial district. The Dings Magnetic Separator Company centralizes by this move all manufacturing activities, which were previously carried on in two plants. In line with the latest color engineering practices, the shops and machine tools are painted in colors recommended to reduce eyestrain and to provide pleasant working surroundings. New equipment and machine tools have been installed throughout; and Dings' officials say that the added floor space and more efficient plant layout will make possible greatly increased production almost immediately.

Considerably enlarged magnetics research and analysis laboratories now enable Dings to analyze samples of industrial materials in carload lots whenever customers desire such analysis as an aid in determining the proper types of magnetic separators to be used in particular applications.

ALLIS-CHALMERS EXPANDS PLANT AT PITTSBURGH

▲ A construction and expansion program to cost several million dollars was announced for the Pittsburgh works of the Allis-Chalmers Manufacturing Company. The first major expansion of the Pittsburgh property since its purchase in 1927 by Allis-Chalmers will include a new 250 × 400 foot building which will be de-

which hydraulic power system is best for you?



There is no one best hydraulic power system for all applications. But whatever your requirements, you can be sure of getting unbiased recommendations regarding them from Wood engineers, regardless of the size or service of the presses you operate, whether it be one or a hundred. This, because R. D. Wood designs and builds not only pressure-storing accumulator systems, but also furnishes all types of direct-pumping units. In each case our engineers recommend the type of equipment best suited to your individual needs, rather than endeavor to sell you some particular type of system. Their experience can prove highly valuable to you. Prompt attention is given all inquiries. R. D. Wood Company, Public Ledger Bldg., Philadelphia 5, Pa.

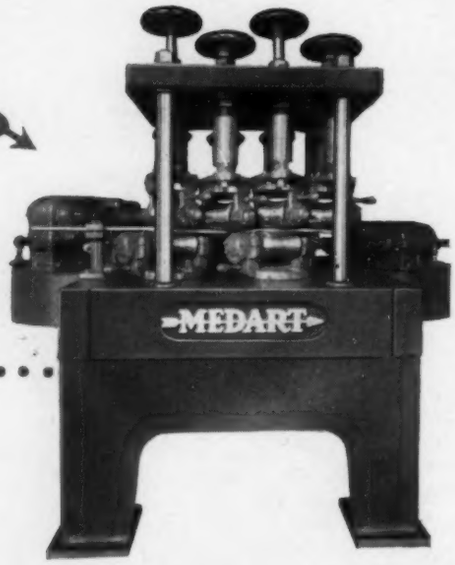
PRESSES AND VALVES FOR EVER

R.D. Wood Company

MEDART MICRO-MULTICYCLE!

straightening machine designed exclusively for ⅛" to ½" bars and tubing.

Small, compact yet built on the same principle and embodying the same advantages as the Medart 6-in-1 Multicycle Straightener . . . positive, synchronized feed . . . one feeding level . . . two bending cycles . . . single motor . . . and the Medart Micro-multicycle has this PLUS FEATURE: all six rolls are driven! A variable feed-speed range is built into the machine. 3 H. P. motor mounted on base of machine.



MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

THE MEDART COMPANY

voted largely to production of transformers, major item manufactured by the company at Pittsburgh. Another smaller building at the new plant will be used for shipping.

Present employment of 1600 at Pittsburgh will be increased from one-fourth to one-third and productive capacity expanded by about 50 per cent. Construction of the new facilities began July 1 and is expected to be completed about November 1.

OXYGEN MANUFACTURING HAS RAPID ADVANCEMENT

▲ The technique of using oxygen to stimulate the heart action of a patient undergoing surgery or to speed up the natural healing process of the body during some kinds of illness is now being initiated in the steel industry to promote chemical reactions in the open hearth process of steelmaking and to speed up the production of steel.

Oxygen is one of the commonest of all elements but its progress as a general industrial tool has been comparatively slow as against some other, rarer elements. For many years the cost of commercially pure oxygen was a barrier to its increased use. Technical papers on the possibilities of this type of oxygen in steelmaking were presented before the American Iron and Steel Institute at least as early as 1920 when several experts formally discussed this subject.

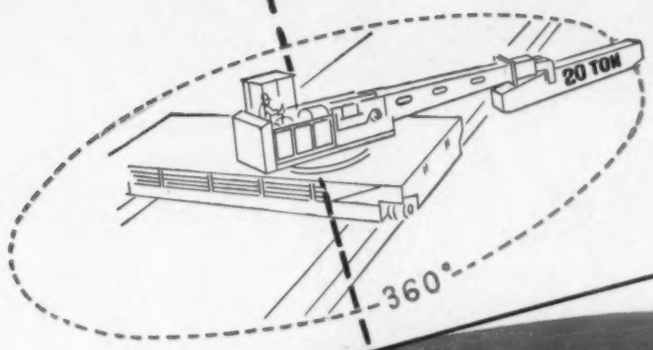
Although still in the development stage, the use of manufactured oxygen in steelmaking is far beyond the stage of experimentation. Full-scale commercial use now depends largely on the speed with which economical oxygen producing plants can be built adjacent to steelmaking furnaces.

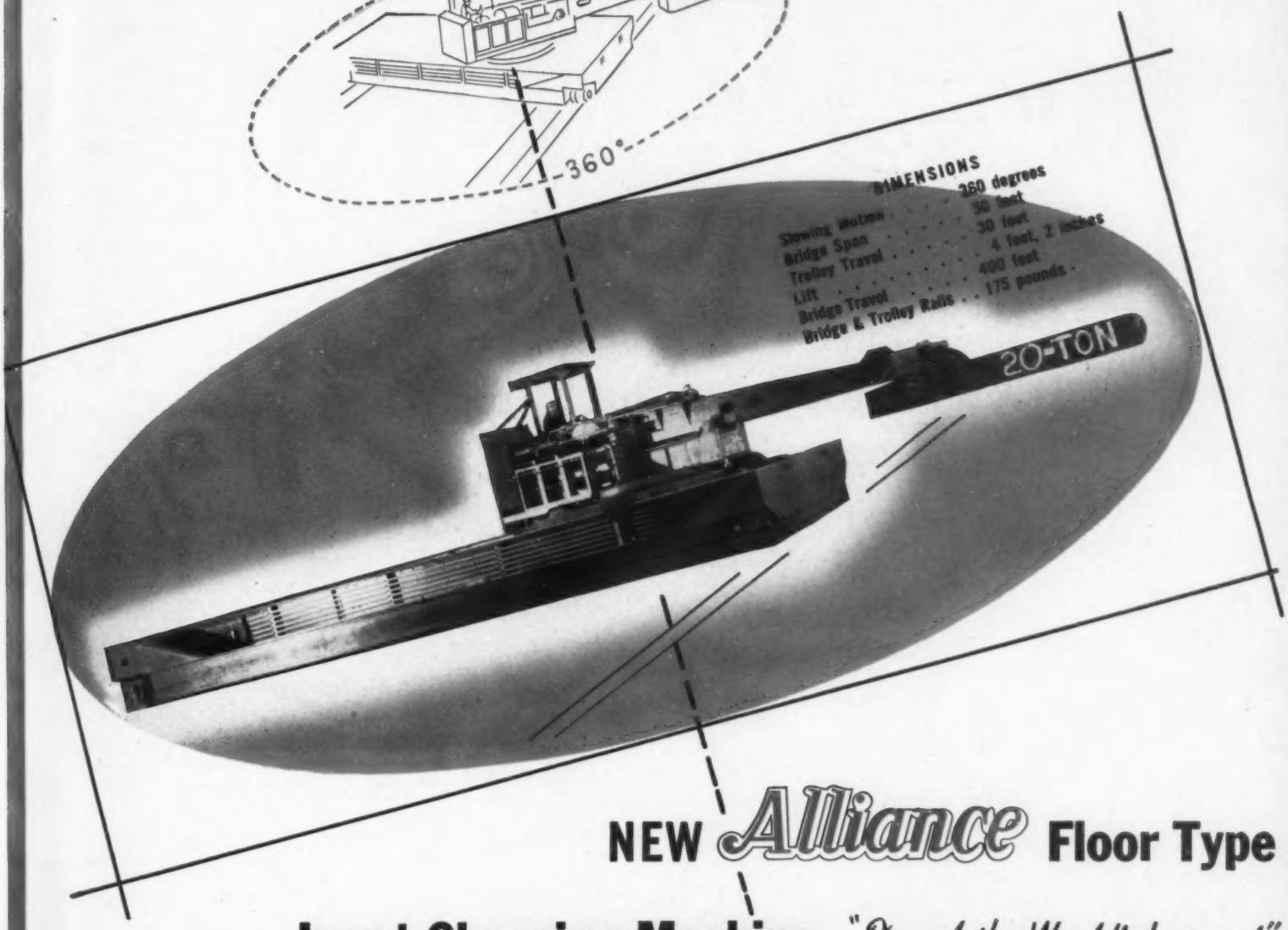
Several oxygen manufacturing plants which will serve steel plants are now under construction, and it is reported they will produce oxygen of 90 per cent purity at about $7 per ton.

Commercial oxygen is used in the manufacture of open hearth steel in two distinctly different ways. One use of it is to enrich the open hearth flame to speed up the melt-down period. This use of oxygen is based on the fact that the oxygen enriched flame is hotter than the conventional flame and so reduces solid scrap and lime-

(*Please turn to page 108*)

Swinging 20 tons of ingot on a 28 foot radius




DIMENSIONS
Slewing Motion . . . 360 degrees
Bridge Span . . . . . 30 feet
Trolley Travel . . . . . 30 feet
Lift . . . . . 4 feet, 2 inches
Bridge Travel . . . . . 400 feet
Bridge & Trolley Rails . . 175 pounds
20-TON

NEW *Alliance* Floor Type

Ingot Charging Machine – *"One of the World's Largest"*

● An ingot charging machine must have great mass and stability to skew 360° with a 20 ton ingot gripped in the peel at 28 foot radius. The hoist must also be of sufficient capacity to handle this tremendous cantilever load. The Alliance ingot charger shown here weighs 400,000 pounds, and is installed in one of America's largest forge plants. . . . The rigid cast steel upper revolving frame turns on conical rollers which operate in a bath of oil. These rollers are supported on one-piece cast steel lower frame. Trolley and bridge move smoothly, each on eight rolled steel track wheels housed in cast steel compensating trucks, a design that reduces wheel loading to a minimum. . . . Alliance builds the equipment to move slabs, ingots, hot metal, raw materials, and finished products safely, quickly and easily. For 50-odd years, plant and steel mill engineers have taken their handling problems to Alliance—World's Largest Builder of the World's Largest Cranes.

LADLE CRANES · GANTRY CRANES
SOAKING PIT CRANES · STRIPPER CRANES
FORGING MANIPULATORS
SLAB AND BILLET CHARGING MACHINES
OPEN HEARTH CHARGING MACHINES
SPECIAL MILL MACHINERY
STRUCTURAL FABRICATION

Main Office — Pittsburgh, Office

THE ALLIANCE MACHINE CO. · Alliance, Ohio · 1622 Oliver Bldg., Pittsburgh, Pa.

How Wing Revolving Heaters Solved the Corrosion Problem of a Cold Strip Steel Mill

A LARGE eastern steel plant had a serious heating problem. In a storage building 112′ x 75′ with 34′ truss height, heated by nearly 4,000,000 Btu/hr wall type heaters, thermostatically controlled, they were continually losing hundreds of dollars worth of finished steel through corrosion.

A Wing sales engineer claimed that the "sweating" which caused the corrosion could only be eliminated by uniformly moving warm air over the entire floor. He offered to demonstrate how Wing Revolving Heaters could accomplish this by using 3 minute smoke bombs to cover the entire area around each pile of cold strip and to dissipate this blanket of smoke in 3 more minutes after the bombs were out.

Two Wing Revolving Heaters were installed and 3 bombs were set off over the fan inlets. The results were perfect. A blanket of smoke covered every pile of strip thoroughly and uniformly, and three minutes after the bombs were out, the smoke was as uniformly dissipated.

These two heaters deliver 2,039,350 Btu/hr giving 70° F. room temperature at 0° F. outside and with one air change per hour. Temperature difference between floor and roof truss varies only from 1° to 2° F.

They have never lost a coil of cold strip since the Wing Revolving Heaters were installed.

Write for Bulletin HR-5

L. J. Wing Mfg. Co., 142 W. 14th St., New York 11, N. Y.

Factories: Newark, N. J. and Montreal, Canada

Wing REVOLVING UNIT HEATERS

(*Continued from page 106*)

stone to liquid metal and slag very rapidly. The flame temperature reached in ordinary open hearth practice is about 3300 F while temperatures of 500 F higher or more are attained by the use of oxygen depending upon methods of use. This hotter flame is achieved with 10 to 25 per cent reduction in fuel and with little or no damage to refractory materials, inasmuch as the maximum temperature prevails for only a few minutes under present practice.

Some operators have reported reduction in melt-down time by as much as 30 per cent of normal practice time, a fact which may make necessary redesign of furnaces and charging equipment to meet the stepped up ability of the furnaces to take metal.

The second use of oxygen in open hearth steelmaking involves bubbling the oxygen into the molten bath and so speeding up the rate at which carbon is removed from the liquid metal. In speeding up that reaction by the introduction of oxygen, the temperature of the bath is increased and that in turn further speeds the reactions.

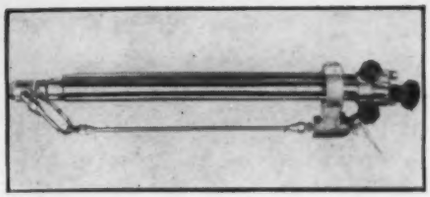
The saving in time in this operation is not as great as in the melt-down period but operators have reported savings of 17 to 30 per cent, depending upon the type of steel melted and the final conditions desired. When oxygen is used directly in the bath it is not necessary to use as much iron ore to promote chemical reaction, an important item for the future consideration of the growing scarcity of domestic ore of open hearth grade.

To make the story complete, some metallurgists have found that the average quality of some types of steel produced by oxygen enrichment methods is somewhat higher than that of similar steels produced by conventional methods.

POWDER-CUTTING UNIT CUTS STAINLESS STEEL

▲ A powder-cutting attachment for the standard "Oxweld" machine-cutting blowpipe has been developed by Linde Air Products Company. The attachment makes it possible for the blowpipe to cut oxidation-resistant materials, such as stainless steels, easily and much more economically than any previous method.

With appropriate sizes of standard



The attachment is composed of a powder valve, a powder nozzle, and an interconnecting powder tube.

nozzles, the powder-cutting assembly will cut all of the common types of stainless steels ranging from ¼ to 3 in. in thickness at speeds of 20 to 7 in. per min respectively. The powder-cutting assembly was designed specifically for intricate shape-cutting, as well as for cutting straight lines and bevels. The assembly will cut all types of stainless steels with equal ease, as well as other high-alloy materials, and cast iron.

The attachment is composed of a powder valve, a powder nozzle, and an interconnecting tube for powder flow. When an iron-rich powder is burned in the oxygen stream, it increases the temperature and oxidizing effect of the oxygen-cutting stream. High heat of combustion permits flying starts in cutting cold steel.

ARMCO STARTS BUILDING TWO ELECTRIC FURNACES

▲ A ground breaking ceremony took place at Armco's East works recently, signalling the beginning of construction of two huge electric furnaces.

Using the same historic silver spade which broke ground for the East works plant 37 years ago, an Armco official inaugurated the $3,000,000 construction project in a formal ceremony.

The two new furnaces will be of the latest design, with rated steel-making capacities of 70 tons each. The construction is expected to be completed early next year. It is planned that approximately 100 to 120 persons will be directly employed in the new department.

The furnaces will give Armco additional ingot capacity in order to utilize the rolling facilities to full advantage. They will stabilize work for the finishing and processing departments and at the same time, give additional tonnage to help meet the pressing demand for more steel by customers.

Production from each furnace is expected to average at least 350 net tons of ingots daily.

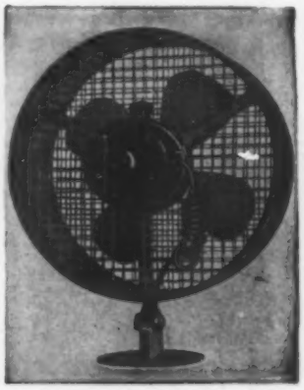
STUDENT ENGINEERS JOIN SCHOOL OF EXPERIENCE

▲ More than 100 engineering students are taking a summer course in the school of experience. Fresh from math and physics finals, each student is headed for summer work in a U. S. Steel subsidiary plant that will advance him in his profession.

The potential engineers, selected under a plan devised by Benjamin F. Fairless, president, United States Steel Corporation, have been assigned jobs in Carnegie-Illinois plants at Homestead, Braddock, Duquesne, Dravosburg, Clairton, and Vandergrift that will dovetail with their professional studies.

Ability and determination to enter the steel industry were the only qualifications for selection of these young millworkers. They come from 34 universities and are sons of farmers, storekeepers, doctors, bartenders, lawyers, and coal miners. A few will be coming

IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep Them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
554 MAIN ST., HARMONY, PA.

Designers and Builders of

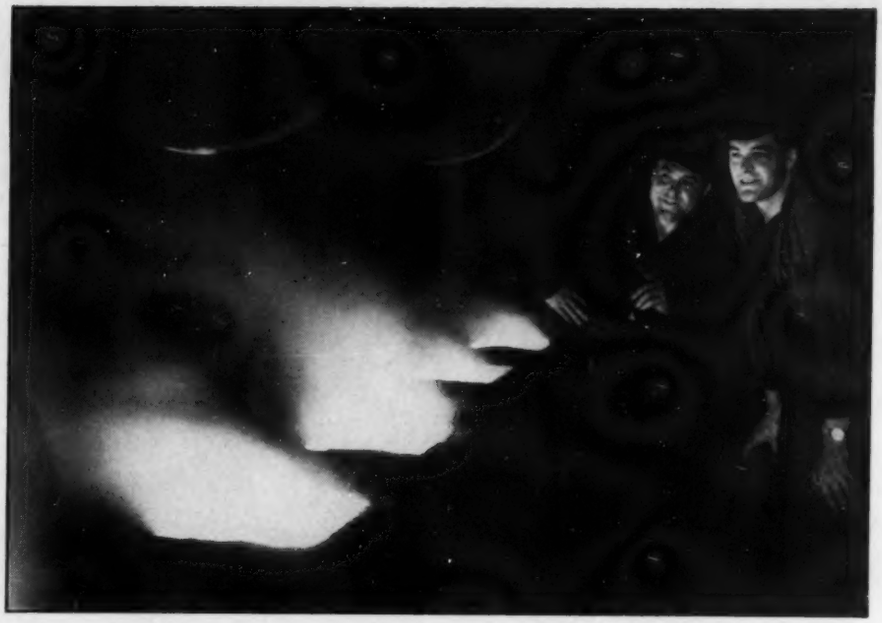
OIL and GAS COMBUSTION SYSTEMS

to Meet Difficult

INDUSTRIAL HEATING PROBLEMS

From Soaking Pits to Forge Furnaces

STEEL PROCESSING CO.
FORT PITT BRIDGE WORKS



English-born Alan Bessemer, a great nephew of Sir Henry Bessemer, inventor of the Bessemer steelmaking process, is studying steelmaking this summer in the Homestead plant of U. S. Steel's Carnegie-Illinois Steel Corporation, Homestead, Pennsylvania. Bessemer is seen here on the right as his attention is being directed to one of the open hearth furnaces by Michael Getsy, a steel pourer.

home to work in the same mill with their fathers.

The summer work, however, will be somewhat at variance with their school work. Hours will be eight per day, and their duties will comprehend practical on-the-job training rather than theoretical examinations and classroom tests. They will have their full share of work to handle.

No tuition is required. They will be paid and required to earn, of course, the wage for their job, and this will permit accumulation of a substantial sum toward defraying next year's school expenses.

There is no final examination but each student-worker will be graded by his supervisor and his performance report will be filed for reference when he returns the following summer and is employed on a job of greater technical content.

Officially designated "Selection and Development of College Recruits," the program is the outgrowth of Mr. Fairless' desire to encourage engineering students by shortening the time required to train an engineer.

FURNACE FIRM ARRANGES EUROPEAN MANUFACTURE

▲ The Pittsburgh Lectromelt Furnace Corporation has recently completed arrangements with Stein et Roubaix, Paris, France, for manufacture of Lectromelt furnaces in France, associates of Stein et Roubaix in Belgium and its colonies. Arrangements have also been concluded with General Electrica Espanola, Bilbao, Spain, for Spanish manufacture.

This arrangement supplements other European manufacture of Lectromelt furnaces by Birlec, Ltd., Birmingham, England, who build Lectromelt equipment for England and the Dominions with the exception of Canada and who have recently arranged facilities in Stockholm for manufacture for Sweden and a similar arrangement has been made in Australia. Lectromelt furnaces for Canada are manufactured by Lectromelt Furnaces of Canada, Ltd.

"BROOM" GOES UP AT HOMESTEAD SLAB MILL

▲ A broom went up June 24 at the new Homestead slabbing mill of Carnegie-Illinois Steel Corporation, heralding a world's record at this United States Steel plant for one month's production of steel slabs.

Flying a broom, bristles skyward, is traditional with steelmakers, signifying a clean sweep of all existing records, and May's output of slabs at the plant did just that.

The new record is 159,792 tons of thick steel slabs. That's more than

8000 tons above the old mark achieved during the war by another Pittsburgh district steel producer.

Slabs are rolled down into thinner steel products, such as plates, sheets, and tin plate. The 159,792 ton output in May would be enough to make sheets for 175,000 automobiles, if it were possible for the mill's entire output to go into that one product.

The new slabbing mill, known as the 45-inch mill, was built and operated for the government by Carnegie-Illinois during the war, to help meet urgent steel needs. It began operating in January, 1944, and has rolled more than four and a quarter million tons of slabs since then. The company purchased the mill from Defense Plant Corporation last year.

VIBRATING SCREEN SIZES VARIETY OF MATERIALS

▲ A new vibrating screen, to be known as the Link-Belt concentric-action screen, is announced by Link-Belt Company as now being available, to meet a constantly-growing demand for economical and effective sizing of a large variety of materials.

The new screen is an inclined floor-mounted or spring-and-cable suspended screen with an ingeniously balanced two-bearing vibrator mechanism which imparts a concentric or circular vibrating motion to all points of the screening surfaces. The screen can be used for both medium and heavy duty sizing as well as for scalping and dewatering or rinsing operations. It is made with double or triple decks and in sizes ranging from 3 × 8 ft to 6 × 14 ft. Single-deck screens can be provided by merely removing the lower deck of the standard double-deck screen.

BLISS EXPANDS PLANTS TO MEET HUGE DEMAND

▲ E. W. Bliss Company is taking steps to meet industry's need for greater rolling mill output, it was announced by Marshall M. Smith, company president.

"With fabricators' requirements still in excess of metal processing capacity, Bliss is hastening to supply the market, both here and abroad,

(*Please turn to page 114*)

The new forged steel CHIKSAN XH Swivel Joint combines the easy turning and effective pack-off — for which all CHIKSAN Joints are noted — with high capacity. Built of forged steel, with flame-hardened races, this new CHIKSAN Joint is designed for heavy duty services of all kinds. It makes possible the fabrication of all-steel lines with perfect flexibility, yet capable of withstanding working pressures to 12,000 psi... with greater safety and longer life. Engineering data on request.

In addition to the new CHIKSAN XH forged steel Swivel Joint, there are over 500 different Types, Styles and Sizes available for pressures from 300 to 3000 psi, and temperatures to 500° F.

REPRESENTATIVES IN PRINCIPAL CITIES

EXPORT REPRESENTATIVE: Chiksan Export Co., Brea, Calif.

Branches: New York 7, Houston 2

CHIKSAN

BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES

CHIKSAN COMPANY

BREA, CALIFORNIA

New York 7 Houston 2

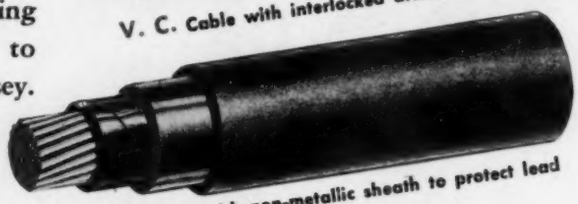
SHORT FACTS ABOUT LONG-LIVED CABLE

OKONITE VARNISHED CAMBRIC CABLES

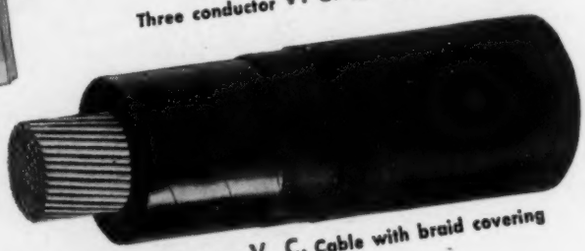
- They can carry a heavier current than rubber insulated wire.
- They are easy to splice and handle.
- They are available in all sizes and for use up to 28,000 volts.
- Bulletin OK-1013 tells the complete story of Okonite varnished cambric insulated wires and cables with illustrations, tables, and current carrying capacities. For a copy, write (using your own business letterhead, please) to The Okonite Company, Passaic, New Jersey.

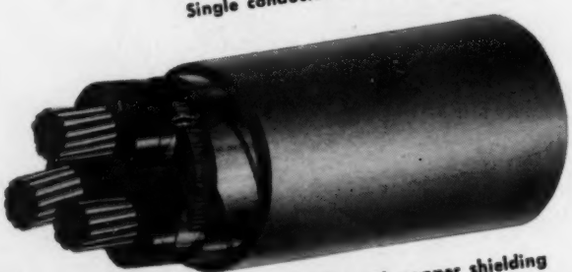
Varnished Cambric switchboard wire (flameproof braid)

V. C. Cable with interlocked armor for indoor use (Type ACV)


V. C. Cable with non-metallic sheath to protect lead

Three conductor V. C. Cable with lead sheath


Single conductor V. C. Cable with braid covering


Three conductor V. C. Cable with copper shielding

OKONITE insulated wires and cables

Best by far for high-speed production

In today's fast-moving production work the modern battery-powered truck has no equal. The development of modern high capacity batteries by Philco, gives trucks for steady, full-shift operation. Philco extra capacity types are widely used—XL, XVL, AMH and the famous long-life Philco "Thirty". Write for catalogs of specification data.

PHILCO

STORAGE BATTERIES

PHILCO CORPORATION • STORAGE BATTERY DIVISION • TRENTON 7, NEW JERSEY

(*Continued from page 111*)

with the rolling mills and accessories necessary to increase the available supply of ferrous and non-ferrous sheet and strip," Mr. Smith stated.

"Toward this end," he continued, "capacity of the Salem, Ohio, division has been doubled by addition of facilities for steel weldment production. At present, output of weldment is about 1 million pounds monthly."

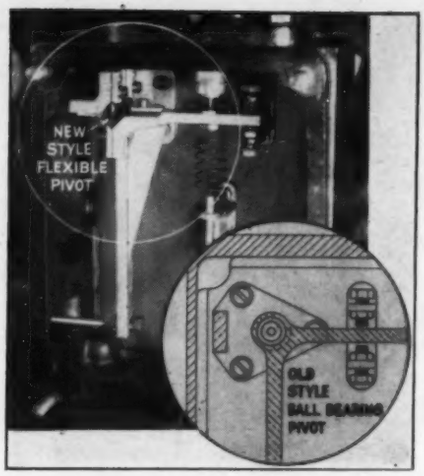
Mr. Smith indicated that the company's other manufacturing divisions will be called upon to share the burden of increased mill orders on a reciprocal basis with the Salem plant, which now figures largely in Bliss's press-building program."

DEVELOP FLEXIBLE PIVOT FOR IMPULSE SIGNALS

▲ To avoid all friction in the transmission of impulse signals, a flexible pivot was developed by Askania Regulator Company for use in all their lever transmission systems for bellows, diaphragms and bourdon tubes.

The design is rigid in itself, so that it can be mounted in any position without loss of calibration of the controllers. As the total motion of the levers thus supported is relatively small — only a few degrees — the spring characteristic is linear and negligible for most applications.

The design avoids troubles to which corrosion or dirt or poor lubrication exposes ball bearings, pivots or shafts.



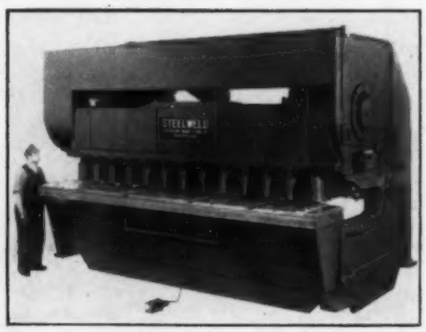
Top circle shows new flexible pivot design contrasted with old style ball bearing pivot shown in lower circle.

BUILD LARGEST SHEAR WITH PIVOTED BLADE

▲ The largest shear ever built employing the pivoted-blade principle of operation was recently completed by Cleveland Crane and Engineering Company. Capable of cutting 12 feet of ¾ in. steel plate, at 30 strokes per minute, the machine has an extra deep 36 in. throat, which permits slitting of very wide plate.

The knife clearance may be varied to suit the thickness of plate being cut. Turning a hand crank, conveniently located on the right end hous-

Steelweld shears have been built for various thickness metal, from 12 gage to ¾ in. and designs have been developed for plate up to 1¼ in.



TYPE A PUMPS FOR GENERAL and PROCESS SERVICES

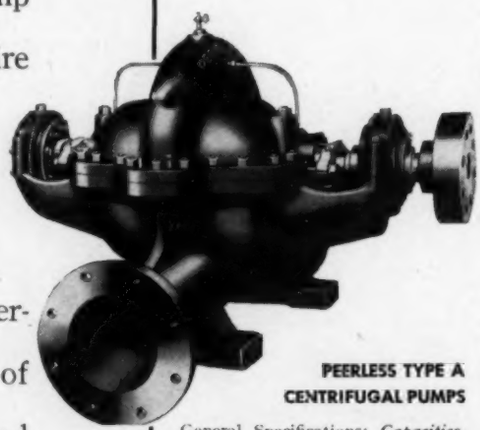
Capacities: 50 to 70,000 G.P.M.

PEERLESS Horizontal Centrifugal PUMPS

(Formerly Dayton-Dowd)

PEERLESS PUMPS

● The Peerless Type A pump is characteristic of the entire line of high quality, heavy duty horizontal centrifugal pumps, manufactured by Peerless to serve the diversified pumping demands of industry, municipalities and water works everywhere.



PEERLESS TYPE A CENTRIFUGAL PUMPS

General Specifications: *Capacities*, from 50 to 70,000 g.p.m.; *Heads*, 15 to 300 feet; *Sizes*, 2" to 42" discharge; *Drives*, electric and other types from 1 to 1000 h.p.; *Type*, single stage, double suction, split-case, ball bearing. REQUEST DESCRIPTIVE BULLETIN.

PLAN WITH PEERLESS

For all your pumping requirements, plan with Peerless. Peerless' comprehensive line of pumps includes Underwriters' approved Fire Pumps for plant fire protection, Boiler Feed and Pipe Line pumps and scores of other vertical and horizontal types producing capacities from 10 to 220,000 g.p.m.

PEERLESS PUMP DIVISION

FOOD MACHINERY CORPORATION

Factories: Canton 6, Ohio • Quincy, Ill. • Los Angeles 31, Calif.
District Offices: Canton 2, Ohio; Philadelphia: Suburban Square, Ardmore, Pennsylvania; Atlanta: Rutland Bldg., Decatur, Georgia.; Dallas 1, Texas; Los Angeles 31, California.

ing, changes the gap between the knives. A large dial indicator indicates the clearance in thousandths of an inch and also shows the plate thickness that may be cut for any knife setting.

The machine is electrically operated by a foot switch which can be moved about the floor to the best working position. The foot switch substitutes tireless toe action for tiresome knee action required by conventional foot treadles. A back-gage which floats on ball bearings is quickly adjusted by a crank placed within easy reach at the right end near the bed of the machine.

SIGNALS "LANE" TRAFFIC AT PLANT DANGER POINTS

▲ For "laning traffic — at dangerous corners, underpasses and abutments — where signals are vitally needed these busy days in the interest of life and property, Lintern Corporation signals offer many advantages. They are equipped with glass reflectors, hoods and high quality lenses giving a brilliant signal under all conditions.

These lanterns are strongly built of steel, securely welded and cadmium plated for long life. All are equipped with hinged doors for easy lamp changes, and are weatherproof and dustproof.

STEEL FIRM HAS RECORD PAYDAY

▲ In the largest single payday in its history, Allegheny Ludlum Steel Corporation on June 24 paid more than $2,000,000 to over 18,000 present and former employees.

The special payday is for the purpose of making payments as a result of inequalities in wage rates during the period from January 4, 1944, through March 31, 1947. This part of the settlement, which was agreed upon by the company and its workers, was in accordance with a directive issued by the former National War Labor Board.

Five company plants participated in the payday. They were: Brackenridge, Pennsylvania, where approximately 9700 workers were paid about $1,130,000; West Leechburg, Pennsylvania, where about 3100 workers received roughly $318,000; Dunkirk, New York, where approximately $359,000 were paid to about 3000 workers; Watervliet, New York, where some 1400 workers received about $165,000, and Buffalo, New York, where approximately $67,000 were paid to about 1000 workers.

An additional payment, the total amount of which equaled two cents an hour during the affected period, was paid later to employees whose wages during that period have been determined to have been below present wage scales.

DESIGN NEW MOTOR FOR INDUSTRIAL HEATING

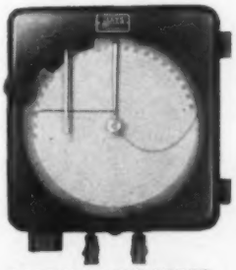
▲ The North American Manufacturing Company has designed a new product known as the Series 600 diaphragm air motor. Pneumatic control system users in the industrial heating field will appreciate the advantages offered by this new motor. It is designed primarily for use with the North American adjustable port

YOU GET BETTER STEEL by this BETTER Modern Method

FURNACE PRESSURE CONTROLLER
Equipped with external manual adjustment for automatically operating stack damper to hold pressure constant.

These Hays Instruments may be used in Combination or Individually.

PRESSURE INDICATOR
An easy-to-read measurement of furnace pressure. Usually connected at the furnace roof.



PRESSURE RECORDER
A 24-hour record of furnace pressure. Shows timing of reversals and each change of pressure made by the operator during the heat.

IN up-to-the-minute open hearth plants you will find an increasing reliance on Hays Pressure Control.

Automatically this simple system regulates furnace conditions --relieves operators of many time-consuming details, gives them more time for more important duties. And Hays instrumentation can be complete or partial.

Here for a fact is "smart business." Better get the facts—write for them, or have a Hays engineer tell you about this better modern method. Representation in all principal cities of the United States and Canada.

The HAYS CORPORATION
SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

but he Wasted Time Today...

Joe has just finished a fair day's work, and he's mighty tired—but it's a fact that he wasted time today. He stayed right on the job—no loafing for him—yet the time he spent lifting and lugging heavy materials and getting heavy work into his machine and out again was not productive time. There are many *Joes* in industry today, but their numbers are decreasing constantly, mainly because plant engineers are learning that continuous flow handling methods eliminate this inefficiency, and are applying these methods. A smooth, controlled flow of materials to machines goes a long way toward increasing production and keeping worker fatigue at a minimum. Mathews Engineers are specialists in continuous flow handling methods, and make available to American and Canadian industry the facilities of three modern strategically located plants, and the benefit of many years of experience in dealing with conveying problems in both light and heavy industry.

MATHEWS CONVEYER COMPANY
ELLWOOD CITY, PENNSYLVANIA

MATHEWS CONVEYER COMPANY WEST COAST
SAN CARLOS, CALIFORNIA

MATHEWS CONVEYER COMPANY, LTD.
PORT HOPE, ONTARIO

Engineering Offices or Sales Agencies in Principal American and Canadian Cities

valves which have the adaptability feature necessary for straight-line control, but it can be used wherever the need for pneumatic control might arise.

Accepted pneumatic controller air pressures of 0 to 15 psi afford an impulse pressure range of 3 to 13 psi to the diaphragm motor which results in full travel of the motor arm (26 degrees) and develops 25 psi torque for 1 lb change in impulse pressure. These ratings are for the No. 600-65 size motor.

Provisions have been made on the diaphragm motor for a valve positioner to obtain the maximum in valve response accuracy. Mounting lugs are provided specifically for fastening to supports independent of the piping and it can be mounted in any position relative to the piping. This new product is now in full production and deliveries can be made from stock.

SALT MANUFACTURER IS EXPANDING FACILITIES

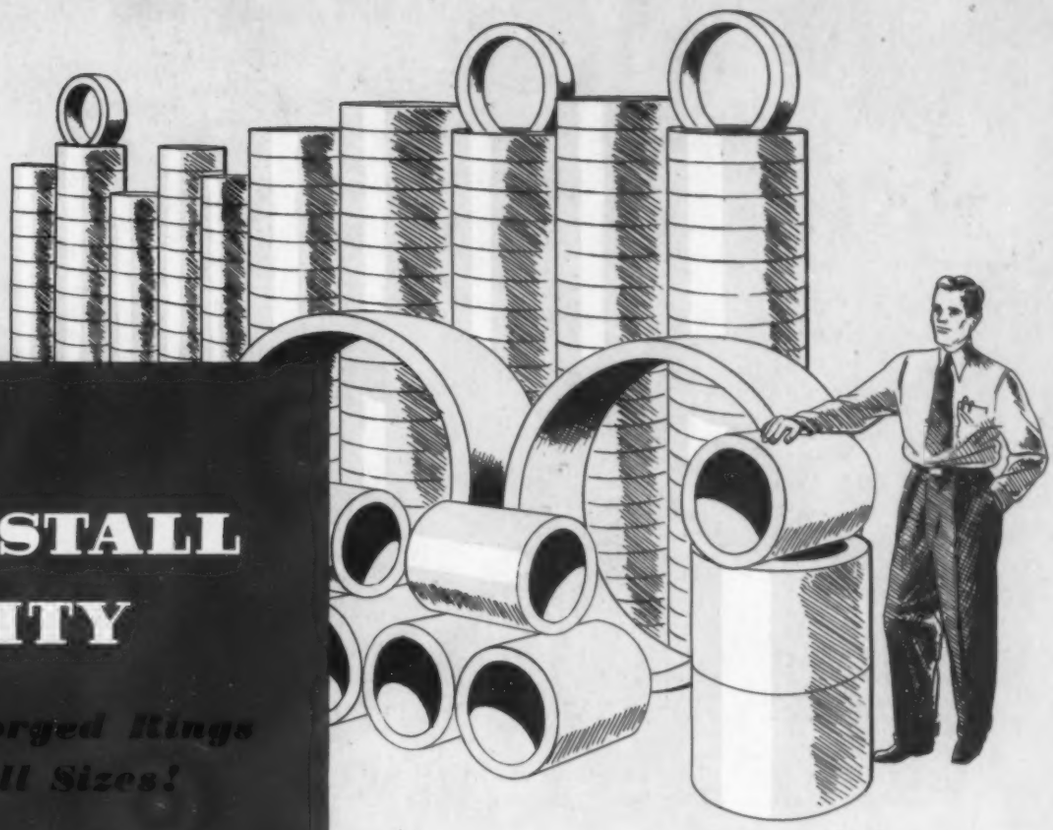
▲ The Pennsylvania Salt Manufacturing Company announced it now has under construction at its Wyandotte plant additional boilers and allied power generating equipment, including a completely new modern power plant building, at a cost of more than $3,500,000.

In addition to new equipment, Pennsalt is installing fly ash collectors for the present three large pulverized-coal burning boilers at an estimated cost of $200,000. The new boilers also will be equipped with the fly ash collectors. These collectors, made by the Western Precipitation Corporation, will remove solid products of combustion in the flue gases in an amount equal to or better than existing municipal requirements.

In the existing boilers the company now is installing new induced draft fans and new motors to take care of the additional draft loss placed on the boilers by the fly ash collecting equipment in the duct system through which products of combustion are discharged. Steel superstructure for the fly ash collecting equipment on the present boilers has been erected and this part of the project will be completed and in operation before the end of this year, Pennsalt officials said.

The new boilers and power equip-

(*Please turn to page 120*)



Now—

HEPPENSTALL QUALITY

Rolled and Forged Rings —and in All Sizes!

For years, we've produced forged-steel rings to meet the specific needs of those who use them in their products or production machinery.

Now, with that experience and after extensive research, we've entered the Rolled Ring field—a new source of highest quality, weldless, rolled and forged steel rings.

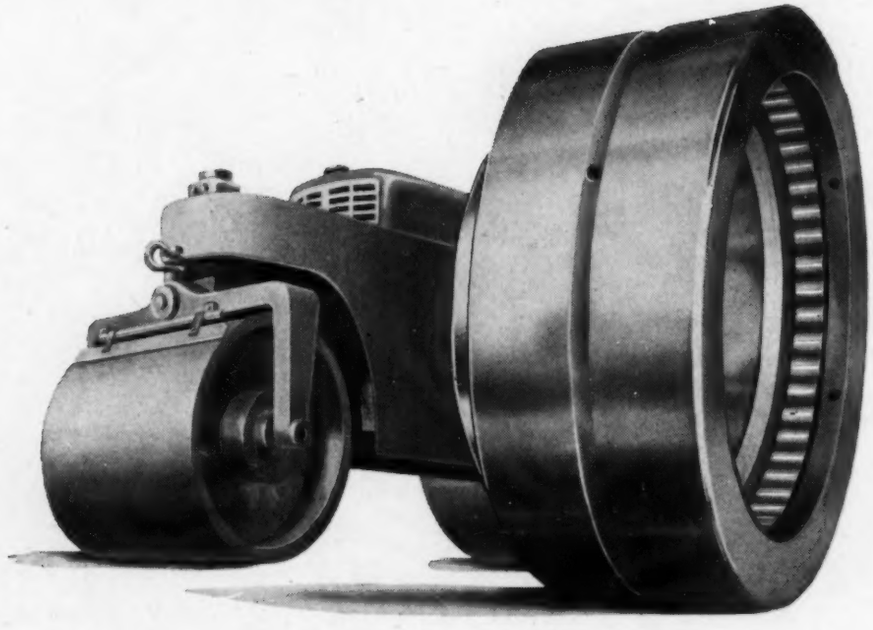
There are strength and wear advantages in forged steel rings . . . Higher internal and external uniformity result from rolling, forging and sizing them on automatic machinery. Heppenstall has that machinery, and can produce rolled and forged rings to your exact specifications for grade of steel and heat treatment—diameters from 6 to 50 inches—wall thicknesses from 1 inch up—sleeve lengths up to 24 inches—quantities from 1 to 100,000—black (as rolled) or rough finished.

If your product, or production machinery, uses a solid steel ring—as a ring, or otherwise finished—Heppenstall is ready to quote upon your needs. Heppenstall Company, Bridgeport 5, Conn.

HEPPENSTALL

the most dependable name in forgings

PITTSBURGH BRIDGEPORT DETROIT



Smooth rolling . . .

is assured by the precision, anti-friction construction of Torrington Type NCS Needle Bearings. Sturdy races and the full complement of rollers provide dependable, low-wear operation

In heavy-duty applications . . .

for loads are evenly distributed over a large area of bearing contact surface. The compact size of NCS Needle Bearings also allows a reduction in size and weight of related parts with no sacrifice in strength.

Other advantages include efficient lubrication, low coefficient of friction for operating economy, and unit construction for easy assembly. To help your equipment perform smoothly with minimum maintenance attention, consider Torrington Type NCS Needle Bearings.

THE TORRINGTON COMPANY

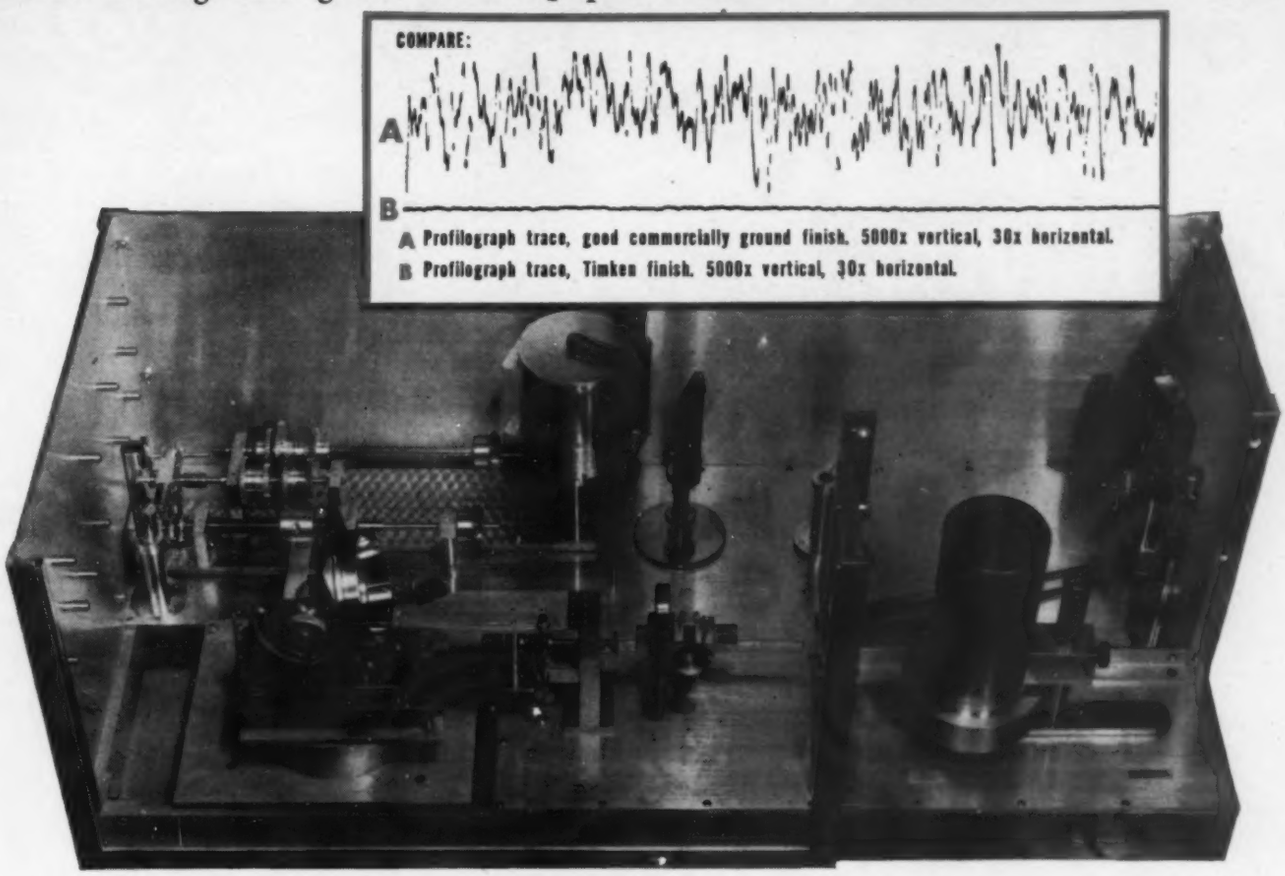
SOUTH BEND 21, INDIANA TORRINGTON, CONN.

Offices in All Principal Cities

TORRINGTON BEARINGS

• NEEDLE • SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • BALL •

Timken bearings make good steel mill equipment better . . . here's one of the reasons why:


COMPARE:
A
B
A Profilograph trace, good commercially ground finish. 5000x vertical, 30x horizontal.
B Profilograph trace, Timken finish. 5000x vertical, 30x horizontal.

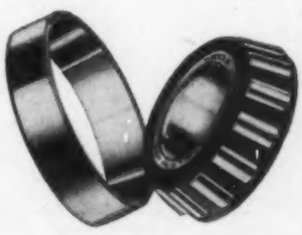
Answers the question— "How rough is smooth?"

ONE of the reasons Timken tapered roller bearings perform with such frictionless, wear-free ease is the amazingly smooth surface finish on the rolls and races —the finest known to modern bearing science.

Now, when you talk about finishes like this, you're talking about surface irregularities of only a few millionths of an inch—irregularities which are impossible to detect by any ordinary means. So, when Timken first began to develop this finish, one of the biggest obstacles was the absence of an accurate method of measuring the roughness of an apparently smooth surface.

The profilograph pictured above was the answer. Developed by Timken in 1928 and steadily improved since then, the profilograph determines surface irregularities to within one-millionth of an inch. Equipped with this measuring stick, Timken engineers were able to develop new finishing methods and machines, which have resulted in the microscopic surface accuracy of the Timken bearings you use today.

Every factor in the efficiency of a bearing is approached at Timken in this same scientific manner. For example, Timken makes its own steel to assure constant quality. And Timken is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels. No wonder you can always be sure of uniformly top quality and performance in the Timken bearings you use. The Timken Roller Bearing Company, Canton 6, Ohio.

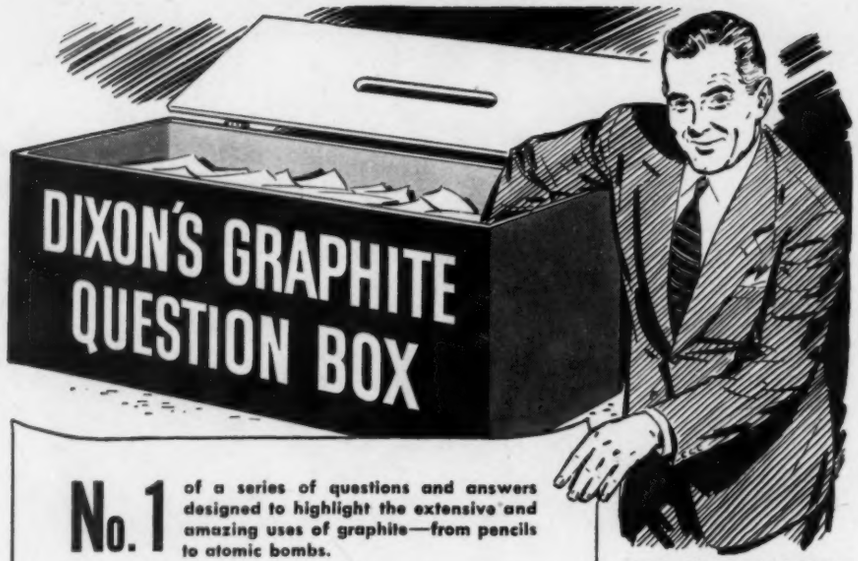


TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◐ AND THRUST —◐— LOADS OR ANY COMBINATION —✳—



No. 1 of a series of questions and answers designed to highlight the extensive and amazing uses of graphite—from pencils to atomic bombs.

SOURCE AND PROPERTIES OF GRAPHITE

QUES. What is graphite?

ANS. One of the softest minerals of the carbon family—believed to be an end product of natural processes involving heat, pressure and time—extremely lubricous or slippery, non-metallic, non-magnetic, non-toxic and non-odorous.

QUES. Where are the principal commercial sources of graphite?

ANS. Madagascar, Ceylon, Mexico and Korea. Some are found in the United States.

QUES. Is there more than one type of graphite?

ANS. Yes. The natural crystalline type is found in laminations of very thin flakes and in vein-like strata of fibrous structure. The natural amorphous type is of rather earthy structure.

QUES. Which type of graphite is obtainable in the highest purities?

ANS. The crystalline varieties, after refinement, run highest in graphitic carbon.

QUES. In what average particle sizes are processed graphites available?

ANS. Over an extremely wide graduated range from an average of 2 microns to large flake sizes containing particles from 1/3 to 2 millimeters.

More on *"Source and Properties of Graphite"* in next ad.

A few of thousands of widely used products containing Dixon's Graphites. Those starred are Dixon products, many of them sold by supply houses everywhere.

★Roll Neck Bar Grease

★Cup Grease No. 3

★Graphite Coating XP 320

Now may we receive *your questions* on how graphite can help *you?*

DIXON'S GRAPHITES

Products of
JOSEPH DIXON CRUCIBLE COMPANY
Jersey City 3, N. J. Div. 12-C-7

LOOK FOR No. 2
in this series. We will gladly send you reprints of any you may miss

(Continued from page 116)

ment will be completed during 1948, it was said. The actual combustion space of these new boilers has been designed to permit use of the lower grade coal which is the only grade now obtainable. These boilers will have a higher steaming capacity than the present ones and will generate steam at pressure and temperature levels which will add to the over-all efficiency of operation of the steam power facilities.

NATIONAL BATTERY BUYS PHILCO BATTERY DIVISION

▲ The Philco Corporation's Storage Battery Division has been acquired and is to be operated by the National Battery Company as a consolidation with its Gould Storage Battery Corporation for the manufacture and sale of industrial storage batteries, John Ballantyne, Philco president, announced recently. The Gould Company will assume warranty and service responsibility for all Philco Storage Batteries now in use and will have the right to continue manufacture and sale of Philco storage batteries during the transition period.

KAISER STEEL HAS RECORD PRODUCTION

▲ Kaiser Steel established a whole new set of record production figures in every department of its Fontana, California, plant during May, according to a report just issued by F. M. Rich, vice president in charge of operations.

The blast furnace (25 ft 6 in. hearth diameter) produced the record tonnage of 41,529 net tons of pig iron (average per day 1340 net tons) on a coke consumption of 1362 lb per net ton, and flue dust production of 45 lb per net ton with a 100 per cent ore burden.

The open hearth shop produced 68,318 net tons of ingots (18.1 net tons per furnace hour) with a fuel consumption of 3,450,000 Btu per net tons.

At the same time, he announced the plant's new pipe mill, which will be the first in the West, and new cold rolling and drawing facilities will be

in operation before the end of the year. A new warehouse, part of the same construction program, has been completed and is in use.

The following table summarizes Kaiser Steel's production for May, together with the totals for the best previous month.

	May tonnage	Previous record	Date previous record
Pig iron	41,529	38,291	May, 1945
Sinter	39,195	33,873	May, 1944
Ingots	68,318	64,454	March, 1947
Soaking pits	64,942	61,327	January, 1947
Plates	14,655	14,075	April, 1947
36 In. mill	53,235	49,092	January, 1947
29 In. mill	29,060	28,075	March, 1947
Merchant mill	16,584	16,329	April, 1947
Rolled products for sale	43,734	40,465	April, 1947
Iron ore mined	115,734	93,228	April, 1947

COMPLETE COAL WASHING PLANT FOR U. S. STEEL SUBSIDIARY

▲ A $1,000,000 project involving the design and construction of nearly 20,000 cubic yards of concrete structures and foundations for one of the world's largest coal washing plants has been completed for McNally-Pittsburg Manufacturing Corporation by Rust Engineering Company.

The work is part of the new high-capacity, modern treating plant being installed by McNally-Pittsburg at the Gary, West Virginia, mine of United States Coal and Coke Company, U. S. Steel subsidiary.

Concrete construction includes a 12,500 ton blending bin, one of the largest structures of this type ever built, and a 6000 ton raw coal bin, both built using sliding forms; a combined refuse bin and suspension bridge anchorage; a domestic coal bin; foundations for preparation building; bridge piers; extensions to two mine dumps; and Barney coal haul, railroad car dump and transfer house.

To pour the huge amount of concrete required, without interrupting existing coal handling operations in the plant's narrow valley site, Rust adopted unusual methods of construction. A mixing plant was erected a mile and a half away and 19,950 cubic yards of concrete were hauled to the site in ready-mix trucks.

This unusual view of an industrial plant site shows a $1,000,000 coal washing plant being built in a valley so narrow that 20,000 cubic yards of concrete had to be hauled from a mixing plant a mile and a half away. The picture was taken looking from a mountain top through a cut which will be the terminus of a conveyor from the refuse bin seen directly below.

R-S Furnace Facts

FOR THOSE CONCERNED WITH QUALITY HEATING OF METALS

They Bought the Best ... not the Cheapest!

Picture shows an oil-fired forced convection type of car-hearth furnace built in 1942 for the American Steel Castings Company of Newark, New Jersey.

The heating chamber handles a charge of 22 tons per heat. Two circulating fans supply 25000 CFM each of air at 600° to 1300° F. for low temperature heat treatment of steel castings.

The inside wall shows one of two alloy ducts which distribute hot air horizontally across the charge from both sides. The return duct in the top of the chamber returns the air to the heater to be restored to temperature.

The vertical white lines on the duct are the connecting joints; the horizontal white lines the thermocouples. A burner safety control prevents operation of burners unless fans are running. Car drive and door-lift operate electrically.

Said a happy steel man in Australia
Who had won a first prize with a dahlia
"It's such a success
I'll name it R-S;
That's another that never will fail ya!"

R-S Furnaces will never fail to keep quality and production at the highest levels. Quite as important: They keep maintenance DOWN. Don't look now, but if your Maintenance is showing, give a serious thought to R-S Furnaces for your next unit. JMLCoPG-1

Typical ingenuities of R-S design are the counterweights, carried to the side rather than hung over the arch where the possibility of chain breakage would invite damage to brick-work. The guard prevents accidents to workers, but is high enough to discourage use as a waste-basket.

R-S Products Corp.

Personnel News . . . .

Harry Saxer, general superintendent of the Aliquippa, Pennsylvania, works of the Jones and Laughlin Steel Corporation, announced his retirement as of June 30, 1947. The retirement of Mr. Saxer completed a career of more than forty-seven years in the steel industry — more than forty years with Jones and Laughlin, and the longest tenure of office as general superintendent of the Aliquippa works in the history of that gigantic plant.

After attending Allegheny High School in Pittsburgh, Mr. Saxer went to work for the American Steel and Wire Company, a subsidiary of the United States Steel Corporation, where he worked for seven years in the blast furnace department.

In 1907, Mr. Saxer applied for a job with Jones and Laughlin as a blast furnace blower. Mr. Saxer continued to work at the Eliza blast furnaces until 1913, when he was transferred to the Aliquippa works as assistant superintendent of the four blast furnaces at that plant. In 1914 he was made superintendent of blast furnaces. In 1918, under his direction, the fifth furnace was added. In 1923 he was made superintendent of the blast furnace and coke works and in 1926 the by-product coke works was put under his direction. In 1927 he was made assistant general superintendent of the Aliquippa works and in 1930, Mr. Saxer became general superintendent.

E. K. Miller was appointed general superintendent of the Aliquippa works of Jones and Laughlin Steel Corporation, succeeding Harry Saxer, who retired June 30, 1947.

Mr. Miller came to the Aliquippa works in 1929 as superintendent of steel works, since which time he has been promoted to assistant general superintendent. He was previously associated with the Tennessee Coal, Iron and Railroad Company.

Mr. Miller is a metallurgical engineering graduate of Sheffield Scientific School, Yale University.

Howard F. Martin was appointed assistant general superintendent of the Aliquippa works of the Jones and Laughlin Steel Corporation recently.

Mr. Martin, born at Kelley Island, Ohio, first started work as an electrician apprentice for the McKinney Steel Company. He came to Jones and Laughlin in 1923 as electrical foreman in the open hearth department, in 1928 was made assistant master mechanic, master mechanic in 1930 and superintendent of maintenance in 1937.

Charles A. Kral was appointed assistant general superintendent, tin mill division, Aliquippa works,of Jones and Laughlin Steel Corporation, effective July 1, 1947.

Mr. Kral, born at Cleveland, Ohio, was first employed in 1911 by the Otis Steel Company, now a part of Jones and Laughlin and was production manager when he resigned in 1925 to go with the Trumbull Steel Company at Warren, Ohio. From 1927 to 1937 he worked for the Wheeling Steel Corporation as assistant general manager at Steubenville.

Mr. Kral came to Jones and Laughlin on June 14, 1937, as superintendent of the tin-plate department.

A. W. Baird, who has been assistant purchasing agent of National Supply Company since 1944, has been appointed to the position of purchasing agent for the company's Spang-Chalfant division. **J. M. Taylor,** who has been in the purchasing department of the company since 1945, has been appointed assistant purchasing agent of the Spang-Chalfant division. Mr. Baird started with National Supply at the Ambridge plant in 1927.

G. J. Hartnett, Jr. was appointed superintendent of planning for the Barberton, Ohio, plant of Babcock and Wilcox Company. Mr. Hartnett, who last April became assistant superintendent of the Barberton works, joined Babcock and Wilcox in Barberton in 1936 after being employed by the company for several previous summers. In 1937, he transferred to the erection department, and spent part of his four years in that department as an erector in Argentina. He returned to Barberton from Argentina in 1941 to become head of the staff engineering department. During the war, Mr. Hartnett served in the Army a total of 15 months during two different periods. He is a graduate of Purdue University with a degree in mechanical engineering.

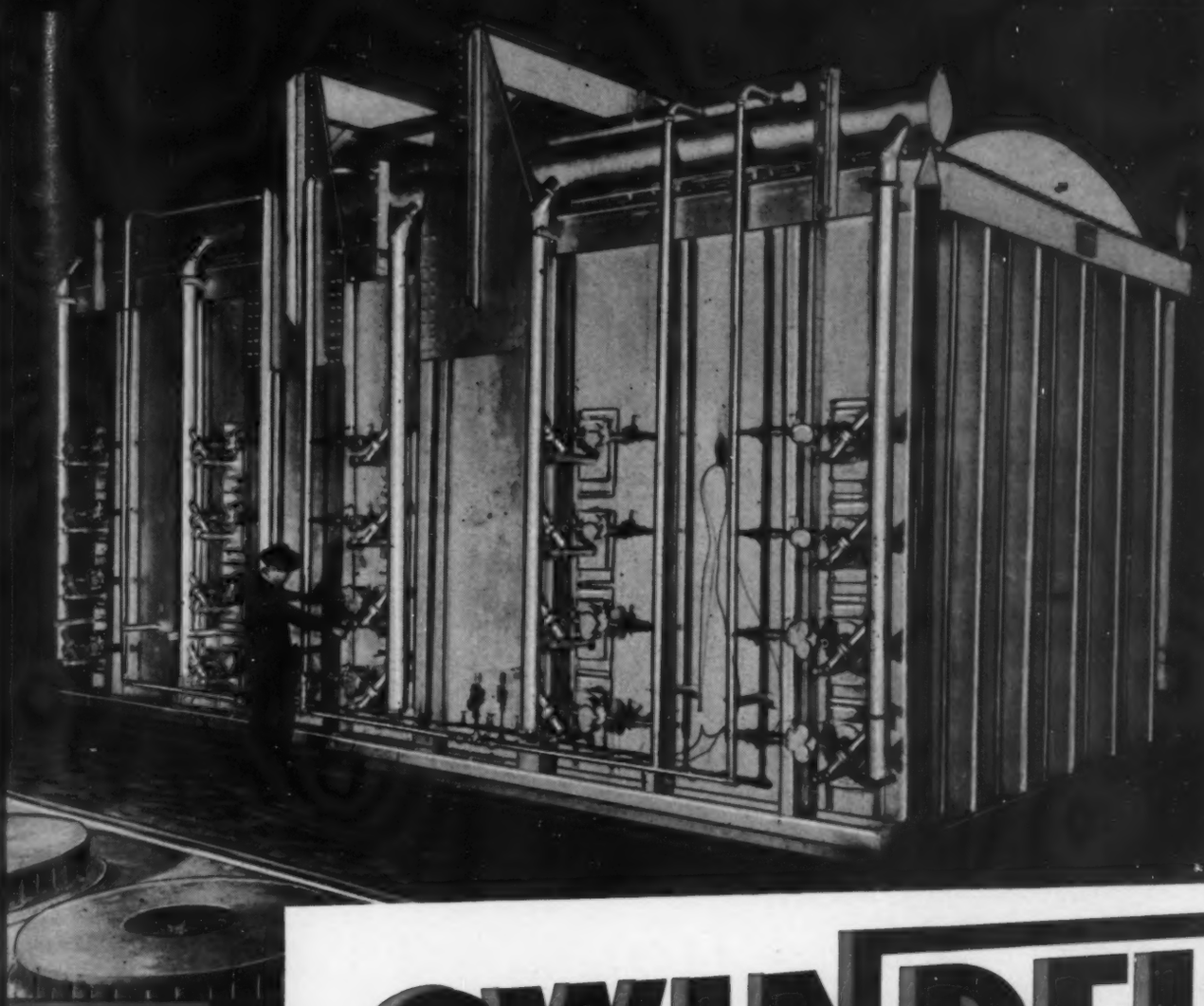
M. Nielsen was appointed superintendent of production for Babcock and Wilcox Company, Barberton, Ohio. Mr. Nielsen, for the past eight years, has been

HARRY SAXER

E. K. MILLER

HOWARD F. MARTIN

CHARLES A. KRAL



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a recent high-capacity furnace installation for a large strip mill.

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NEW OHIO ELECTRIC MAGNET CATALOG

New illustrated Catalog gives latest information on how Improved Ohio Lifting Magnets can solve your metal handling problems...faster... more efficiently...at lower costs.

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Gives details on superior construction features and lists wide range of sizes to fit every industrial need.

Send for your copy of the new catalog on Improved Ohio Lifting Magnets today.

THE OHIO ELECTRIC MFG. CO.
Chester Bland, Pres.
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superintendent of marine erection, with offices in New York. He joined the company in 1924 as an erector of stationary boilers, working out of the Chicago office. He then successively held the positions of district erection inspector in Chicago, and district erector in Cincinnati.

W. C. Snyder, Jr. has been appointed a vice president in the engineering and construction division of Koppers Company, Inc. Mr. Snyder will be assigned to direct one of the major construction projects in which the company is now engaged. He succeeds **John F. Byrne,** vice president, who was killed May 30 in the Maryland crash of a commercial airplane which took the lives of 53 persons.

Mr. Snyder has had more than 20 years experience in engineering and construction work, particularly in the building of steel mills and plants associated with the steel industry.

As president and general manager of the Lewis Foundry and Machine division of Blaw-Knox Company from 1937 to 1945, he had over-all supervision of the construction of the first Kaiser rolling mill at Fontana, California, a portion of the rolling mill of the Geneva

W. C. SNYDER, JR.

(Utah) government steel plant now owned by U. S. Steel, and numerous mills in Argentina, Brazil, Sweden, France, Belgium, and England.

A native of Snow Shoe, Pennsylvania, Mr. Snyder was educated in public schools there, at the Army and Navy Prep School in Washington, D. C., and at Harrisburg Academy. He attended the engineering school at Lehigh University, working in the Engineering Corps of the Lehigh Valley Coal Company during summer vacations.

In 1926 he was hired as a laborer by the Wheeling Mould and Foundry Company at Wheeling, West Virginia, and later that same year became employed in their chemical and metallurgical laboratories.

He went to work for the Lewis Foundry and Machine division of the Blaw Knox Company in 1927, and in 10 years rose through positions as manager of the foundry and vice president in charge of sales, to the position of president and general manager. He also was a vice president and member of the board of the Blaw Knox Company, and a member of its executive committee.

In 1945 he became president and general manager of the Continental Foundry and Machine Company, a position from which he resigned recently.

E. C. Smith, chief metallurgist of Republic Steel Corporation received a degree of doctor of science from Case Institute of Cleveland, Ohio.

Mr. Smith has been with Republic Steel Corporation and its predecessor companies since World War I, at which time he was an inspector for the government in the Central Steel Company plant in Massillon, Ohio. He is a graduate of Ohio State University and studied metallurgy at Columbia University. He was a member of the American Steel Mission to England in 1942 and served on various war metallurgical committees in this country.

Louis J. Rohl has been appointed chief metallurgical engineer of Carnegie-Illinois Steel Corporation, succeeding **E. T. Barron,** who is retiring after 42 years service. A native of Elgin, Illinois, Mr. Rohl studied chemical engineering at Armour Institute of Technology and metallography at the Case School of Applied Science. He was first employed by Carnegie-Illinois at the South Chicago works in 1917. He advanced to manager of the Chicago district metallurgical department in 1943 and last April became assistant chief

LOUIS J. ROHL

metallurgical engineer with headquarters in Pittsburgh.

Mr. Barron was born in Connellsville, Pennsylvania. His career with Carnegie-Illinois began in 1905 at Duquesne works, following his graduation from Massachusetts Institute of Technology with a degree in mining and metallurgical engineering. He became chief metallurgical engineer in 1942.

Dr. Harvey C. Rentschler retired July 1 after a 30-year career of directing Westinghouse lamp and electronic tube research at Bloomfield, New Jersey.

Dr. Rentschler resigned a faculty post at the University of Missouri, where he had taught physics nine years, to join the Westinghouse research laboratories in East Pittsburgh, Pennsylvania, in 1917. A few years later he came to Bloomfield to establish the company's lamp research laboratories.

John DeHetre has been appointed development engineer on the operating staff of Youngstown Sheet and Tube Company at Youngstown, Ohio. He formerly was field engineer for Youngstown Steel Products Company of California, a subsidiary company. Mr. DeHetre joined Youngstown Sheet and Tube Company in 1938 as an assistant field engineer in California. During the

CRANE BUILDERS Since 1903

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Capacities 5 to 150 Tons

Designed and Engineered to Meet Your Requirements

Any Span or Lift
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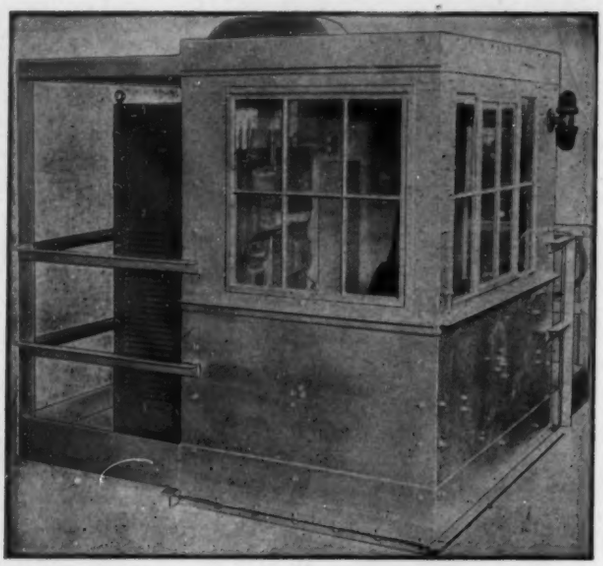
Provides a Method of Burning Small Quantities of Heavy Fuel Oil at Each Burner

The atomizer operates on high pressure steam. It atomizes a reasonable quantity of oil and then divides and distributes this quantity into equal parts, which are delivered to a number of small burners.

An easy system to control. A workable method for a combination oil/gas application to small gas burners. Suitable for oil application to burners requiring 1½ to 3 g.p.h.

BLOOM ENGINEERING CO.
857 W. North Avenue Pittsburgh 12, Pa.



14 Lintern Aire-Rectifiers
for General Purpose Cranes in a Western Steel Plant.

These two views show a Lintern Aire-Rectifier on a general purpose crane. The crane operates in temperatures up to 140° and the Aire-Rectifier pulls the temperature in the cab down to 82° to 85°.

Furthermore, the Aire-Rectifier has activated carbon canisters for the removal of fumes and gases, thereby assuring clean, healthful air for the operator. Another feature of this job is the heating equipment — heater to provide comfortable temperatures in winter operation.

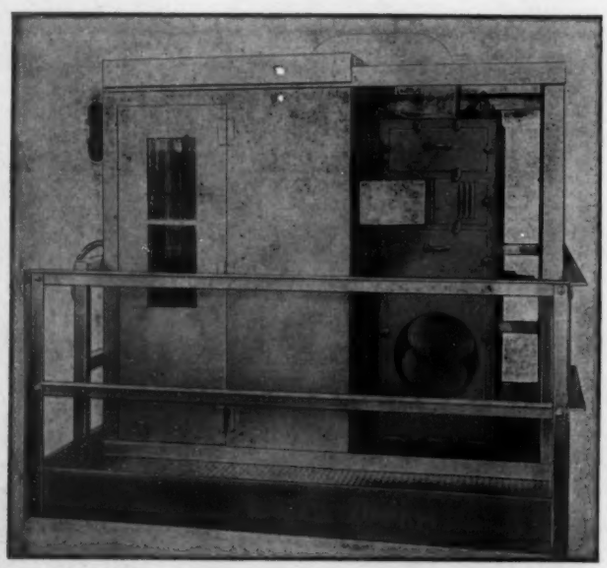
The installation involved 14 Lintern Aire-Rectifiers to condition the crane cabs of all the general purpose cranes operating in excessive temperatures in this plant.

Whatever your crane cab conditioning problem, let's talk it over. Ask for Bulletin AC 111546.

THE LINTERN CORPORATION

54 LINCOLN AVENUE · · BEREA, OHIO

Glowlite Signals, Lanterns, Sanders, Shock Absorbers for Lamps, Ventilating Heaters, Aire-Rectifiers for Overhead Cranes.



war he was on leave of absence two years to serve as assistant chief engineer for Hillman-Kelley Company of Los Angeles, manufacturers of aircraft assemblies and gun mounts for tanks.

Archie S. Ray, roller foreman of the Brier Hill round mill, has been appointed assistant superintendent of the Brier Hill blooming and round mills of Youngstown Sheet and Tube Company, succeeding **Melvin Shaulis** who became superintendent earlier in the year. Mr. Ray joined The Youngstown Sheet and Tube Company 21 years ago as an operator on the old sheet bar mill at Brier Hill.

Harry Dobrin has been named president of Furnace Engineers, Inc., Pittsburgh, Pennsylvania. Mr. Dobrin,

HARRY DOBRIN

formerly executive vice president, is one of the founders of the firm.

Robert S. Douglas has been appointed secretary to the president of Youngstown Sheet and Tube Company. Mr. Douglas succeeds **Paul M. Haas** who was recently appointed general auditor of the company. After six years as a high school teacher in Struthers, Ohio, Mr. Douglas joined Youngstown Sheet and Tube Company 10 years ago as a timekeeper in the seamless tube mill. He was transferred from that to pay and time, became a production clerk in the rod and wire department, then a cost clerk, and was moved to the paymaster's office and later was named secretary to the general superintendent of the Youngstown district.

K. L. Konnerth was appointed general manager of operations and **A. J. Breitenstein** will succeed him as assistant to president in charge of engineering for H. C. Frick Coke Company and United States Coal and Coke Company.

Mr. Konnerth started with United States Fuel Company (now United States Coal and Coke Company) in 1923 at Westville, Illinois, as an electrical draftsman and in 1926 was transferred to Frick headquarters in Uniontown, Pennsylvania, as assistant electrical engineer. He became chief engineer for the company in 1941 and was named assistant to president three years ago.

Mr. Konnerth is a native of Erie, Pennsylvania, and was graduated from Carnegie Institute of Technology in 1918 with a degree in electrical engineering. He was commissioned as an ensign following his graduation

AISE PAST PRESIDENT DIES

A. C. CUMMINS

A. C. Cummins died July 10, 1947 in Youngstown, Ohio. Mr. Cummins was general superintendent of the Youngstown district of Carnegie-Illinois Steel Corporation. Mr. Cummins, a graduate of Lehigh University, was associated with Carnegie-Illinois and the former Carnegie Steel Company since 1911 when he was employed as an electrical draftsman at the Duquesne, Pennsylvania, works. He served in various engineering, construction and operating capacities at Duquesne works for several years, and in 1919 was named superintendent of the electrical department. He was appointed assistant general superintendent of the plant in 1932 and a year later became general superintendent. In August 1936, he was appointed assistant manager of Pittsburgh district operations of Carnegie-Illinois Steel Corporation. In April 1940, he was moved to Youngstown, Ohio to become general superintendent of all Carnegie-Illinois Steel Corporation's operations in the Youngstown area.

Mr. Cummins, a life member of the Association of Iron and Steel Engineers, served as president of the Association for the year 1925, and was an honorary director on the board of directors for several years.

from the Navy's school of steam engineering during World War I.

Mr. Brejtenstein has been chief engineer of Frick since February 1944. He started with the company three years earlier as assistant mining engineer and became assistant chief engineer in 1942. A native of Bridgeport, Ohio, he was graduated from Ohio State University in 1926 and from Massachusetts Institute of Technology in 1931 with a master of science degree in mining engineering.

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with
KLING HIGH SPEED FRICTION SAWS
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10 Seconds 3" Square
15 Seconds 4" Round
11 Seconds 6" O.D. Tube ½" Wall

Friction sawing is one of few mechanical processes which employ the heat of friction in a useful manner. It concentrates heat on the material to be severed at a rate which is faster than it can absorb heat. The immediate temperature rise of the contact surface is so great that its strength is reduced considerably lower than that of the colder blade rim. This heated surface is readily removed by the blade and permits complete severing of the material rapidly with no loss of metal from the blade.

Because of its versatile ability to cut many varied structural shapes, as well as solid or hollow bars in any sequence, without change of blade or set-up, one machine can handle a volume of cutting that would otherwise require several separate shears or slow speed saws.

Consult Kling engineers regarding your metal cutting problems. State size of material to be cut. Bulletin No. 9200 giving full particulars and suggestions as to the type and size of saw will be mailed promptly. No obligation.

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Punches; Bar, Angle and Rotary Shears; Combination Shear, Punch and Copers; Plate and Angle Bending Rolls; Heavy Duty Grinders

1324 N. KOSTNER AVENUE, CHICAGO 51, ILLINOIS, U. S. A.

W. S. Hall, who was recently retired as the chief engineer, Chicago district, Carnegie-Illinois Steel Corporation, Chicago, Illinois, has accepted a position as client's representative for United Engineers and Constructors, Inc., 826 Conway Building, Chicago, Illinois. Mr. Hall served as president of the Association of Iron and Steel Engineers for the year 1922.

George J. Stanley, director, vice president and general sales manager for Aluminum Company of America, was retired as vice president and general sales manager on July 1. He will continue as a director of the company.

John R. Johnston was appointed assistant general manager of sales, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania. He will be succeeded as manager of sales in the Milwaukee district office by **Charles E. McIntyre,** who was formerly assistant manager of sales in the Detroit district sales office.

Mr. Johnston has been with the company for the last 22 years. He started as a sales student in the Gary steel works at Gary, Indiana, and progressed through various plant and sales positions to executive posts in the Chicago and Milwaukee district sales offices. He was assistant manager of the Carnegie-Illinois district sales office in Chicago for seven years before going to Milwaukee to the position he leaves to accept his new post.

R. Herbert Knapp has been appointed chief engineer of U. S. Steel's coal mining subsidiary, H. C. Frick Coke Company. Mr. Knapp, a native of Atlanta, Georgia, attended the Georgia School of Technology and Columbia University, where in 1930 he received a bachelor of science degree in mining engineering and an engineer of mines degree in 1931.

He has had extensive experience in mining operations, including the Cerro de Pasco operation in Peru and service as senior coal mining engineer with the board of economic warfare of the United States government.

His service with the U. S. Steel Corporation started on March 8, 1943, when he was employed as assistant mining engineer of the H. C. Frick Coke Company. In 1945 he was promoted to mining engineer, the position he has held until his present appointment.

F. L. Ebersole, formerly mechanical engineer, American Rolling Mills, Middletown, Ohio, has joined Loewy Construction Company, Inc., New York, as assistant chief engineer of the rolling mill division. He has spent over 35 years as engineer in various branches of the steel industry.

E. E. Brayshaw, formerly assistant division superintendent, operating department, Carnegie-Illinois Steel Corporation, Clairton works, Clairton, Pennsylvania, has been appointed works manager, of Southwest Steel Rolling Mills, Inc., Los Angeles, California.

Gilbert A. Bunn was appointed as district manager of the Philadelphia district of Kennametal, Inc. Mr. Bunn has been a Kennametal representative in the central area for many years.

Cecil U. Zorn, contracting engineer of the Ambridge, Pennsylvania, plant of American Bridge Company, has been transferred to the Elmira Heights plant of this United States Steel Corporation subsidiary, succeeding **J. R. Thompson** who is being made contracting manager of the Boston, Massachusetts, district office of the company, it was announced today. Mr. Zorn was born in Denmark, South Carolina, and is a graduate of The Citadel, Charleston, South Carolina. During World War II he was a first lieutenant, Fifteenth Engineer Battalion with the Ninth Infantry Division. Mr. Zorn joined American Bridge Company in 1945 as a draftsman, and was made contracting engineer at the Ambridge plant in 1946.

Formation of a new turbo-power development department in the engineering development division of the Allis-Chalmers Manufacturing Company has been announced by **W. C. Johnson,** executive vice president of the company's general machinery division.

R. C. Allen has been named manager and chief engineer of a new turbo-power development department at Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin. **W. A. Yost,** formerly assistant manager, succeeds Mr. Allen as manager of the steam turbine department.

S. W. Pollock has been placed in charge of Okonite Company's new sales office in Cincinnati, Ohio. This branch is located in Room 516, Building Industries Building.

E. H. Vedder was appointed manager of the newly-formed electronic control engineering section of Westinghouse Electric Corporation's industrial control division at Buffalo, New York. **R. W. Staggs** was named manager of the electronic control sales section, with responsibility for sales activities of resistance welding control. **C. B. Stadum** was appointed manager of the resistance welding engineering section and **W. G. Roman** was named manager of the electronic section.

YES,
YOU CAN GET
FALCON
CASTING QUALITY
AND PROMPT DELIVERY
ON THE KINNEY
REFRACTORY LINED TUYERE COOLER

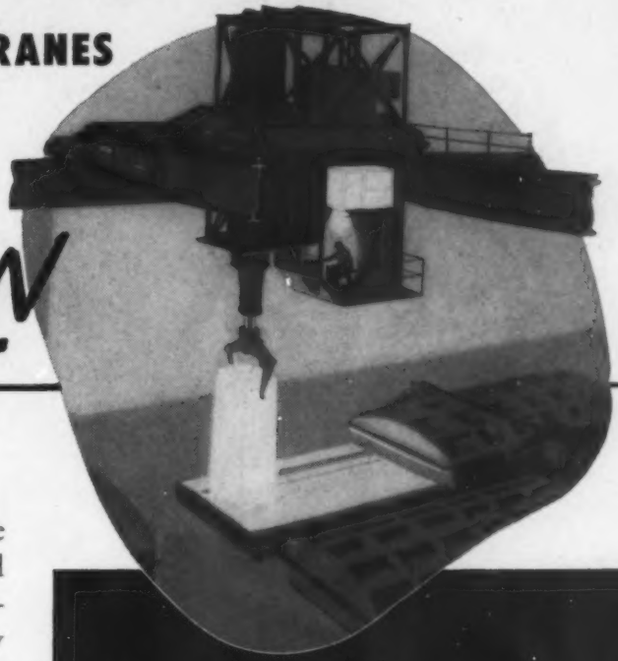
● Falcon's specialized non-ferrous service to the Steel Industry includes licensed production of this advanced design in tuyere coolers. The refractory, which may be brick or quick setting cement, protects the tuyere cooler from hot metal which may cut back through the tuyere and blow-pipe. Covered by Patent Application Serial No. 530153.

● High Grade Copper Cooling Castings for Blast Furnace Requirements.
● Standard and Special Tuyeres.
● Bronze Bearings of any type but specializing in Steel Mill Rolling Bearings.
● Electrodes used in production of electrically welded pipe or tubing.
● Copper Welding Rolls. U. S. Patent No. 1,973,880.

TELEPHONE COLLECT—3-4355
FALCON
BRONZE CO.
YOUNGSTOWN 3, OHIO
Established 1890 · Incorporated 1895

You can eliminate OPERATING HAZARDS ON HOT METAL CRANES

RIGHT NOW

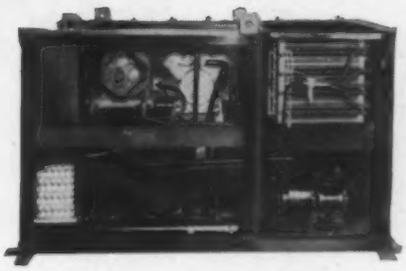


SINCE cranes were first employed to handle hot metal, the steel industry has been faced with the problem of protecting the crane operators from excessive heat and fumes. Many unsuccessful attempts were made to make the cabs of these hot metal cranes habitable. Dravo's application of modern air conditioning principles has developed a safe, practical solution to the problem.

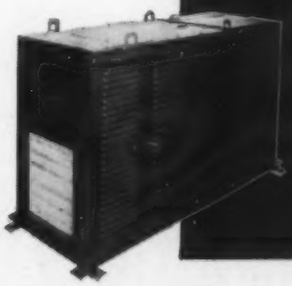
Hot metal crane operating hazards—excessive heat—obnoxious gases—dust—unpleasant fumes—have always been a real impediment to crane safety. You can eliminate these hazards right now with DRAVO CRANE CAB COOLERS.

Proved in actual operation in the hot spots, DRAVO CRANE CAB COOLERS have adequate capacity for installation on any type of soaking pit, ladle, stripper, converter or furnace crane.

● Soaking Pit Crane with Dravo Crane Cab Cooler mounted directly over the operator's cab.



● All parts of the Dravo Crane Cab Cooler are readily accessible for maintenance, panels can be removed without tools.



● Completely self-contained unit requires only power connection and control wiring in cab.

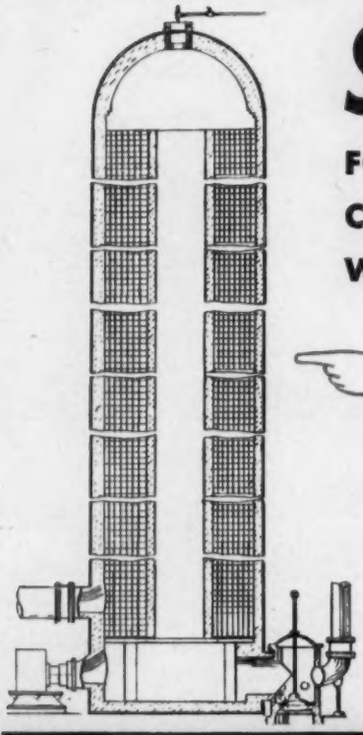
***There's no need to delay*—DRAVO CRANE CAB COOLERS *are available for service* THIS SUMMER.**

DRAVO CORPORATION

Pittsburgh • Philadelphia • Cleveland • New York • Detroit • Atlanta • Wilmington

PITTSBURGH PIPE CLEANER

Steel Mill Service



FOR HEARTH JACKETS • • FEED and DISCHARGE LINES CIRCLE PIPES • • FEED WATER LINES to STOVES • • WASTE WATER LINES • • WATER and GAS MAINS • • SEWERS • • ALL KINDS and ALL SIZES

BLAST FURNACE CHECKER CLEANING A SPECIALTY. FOR ALL TYPES OF BRICK.

Let us show you how Pittsburgh's advanced, scientific pipe cleaning methods can speed up production and reduce maintenance costs in *your* plant. The experience gained on hundreds of difficult pipe and tube cleaning jobs is yours when you call in a Pittsburgh Pipe Cleaner specialist TODAY.

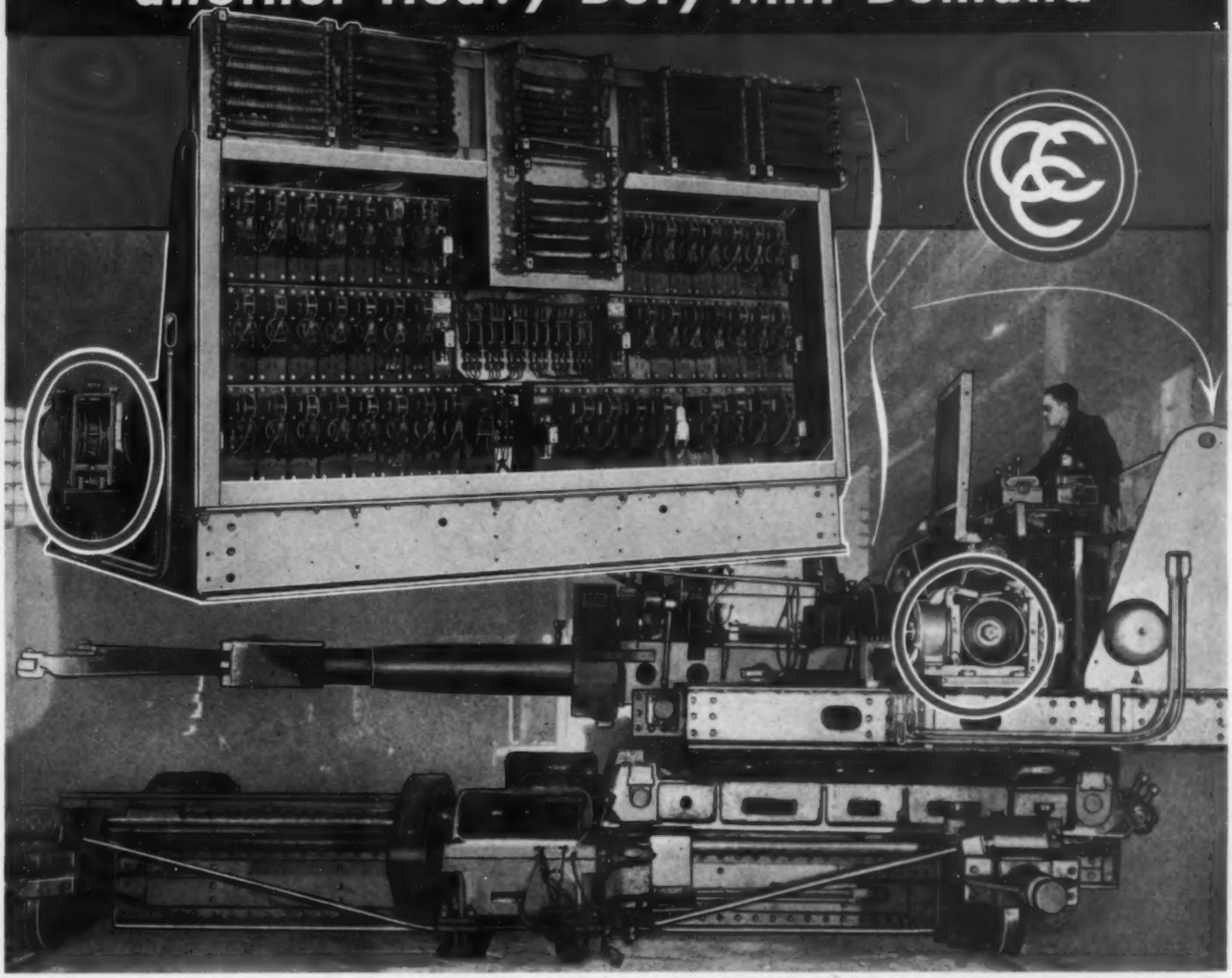
AN INTEGRATED ENGINEERING AND OPERATING SERVICE SPECIALIZING IN THE CLEANING OF PIPES AND TUBES OF ALL SIZES AND ALL KINDS.

PITTSBURGH PIPE CLEANER COMPANY

133 Dahlem St., Pittsburgh 6, Pa.

PHILADELPHIA · BALTIMORE · WASHINGTON · NEW YORK · BUFFALO · CHICAGO · CINCINNATI · ST. LOUIS · DETROIT · BOSTON

CLARK CONTROL *and* BRAKES *fill another Heavy-Duty Mill Demand*



All operations of this Floor-Type Wheel Charger are magnetically controlled by CLARK Heavy-Duty mill apparatus. Previous to this CLARK magnetic control installation, all operations were manually controlled—a laborious task with plenty of maintenance needed.

CLARK Magnetic Control, using Bulletin 7400 Varitime Contactors, which have a built-in adjustable time-delay feature, definitely eases the starting load on motors, thus reducing maintenance.

The CLARK magnetic control panel, complete with Bulletin 110 Edgewound Resistors, is built into that section of the Charger directly back of the operator. Removal of metal doors makes the control panel easily accessible for inspection and maintenance.

CLARK Bulletin 106 Shoe Brakes (circled in red) provide rapid, smooth, braking action with no severe shock to the connected mechanism.

Only ONE maintenance adjustment—for brake-lining wear—is necessary. DURING OPERATION or WHEN THE BRAKE IS IDLE, you see at a glance when lining wear makes adjustment necessary. You just look at the TOP of the Brake—not at the bottom—not at the sides—not at the ends—but on TOP—where the entire adjustment is made—where you can see what you're doing, and can get at it easily.

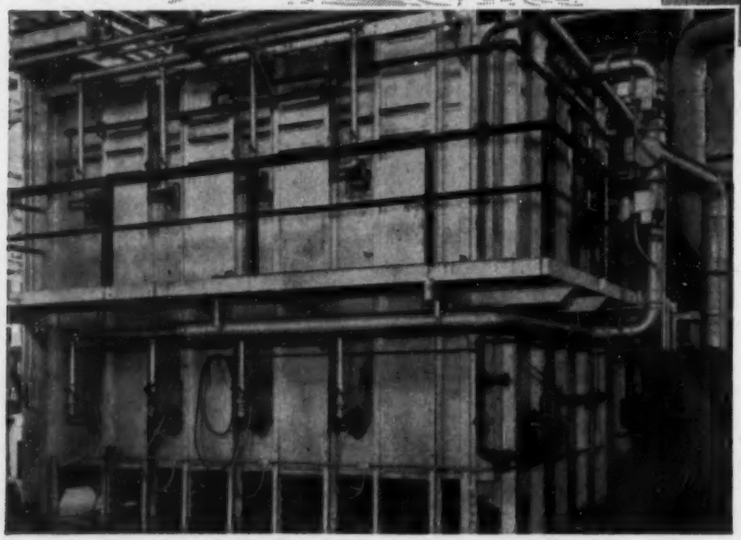
Our nearest District Office or Agency will gladly cooperate with you on Mill Control problems.

THE CLARK CONTROLLER CO.

EVERYTHING UNDER CONTROL • 1146 EAST 152nd STREET, CLEVELAND 10, OHIO

LOFTUS

Tailor-Made FURNACES



FOR EVERY JOB in the Steel Mill

Pictured on this page are three of the many and varied types of industrial furnaces designed, engineered and constructed by the Loftus Engineering Corporation.

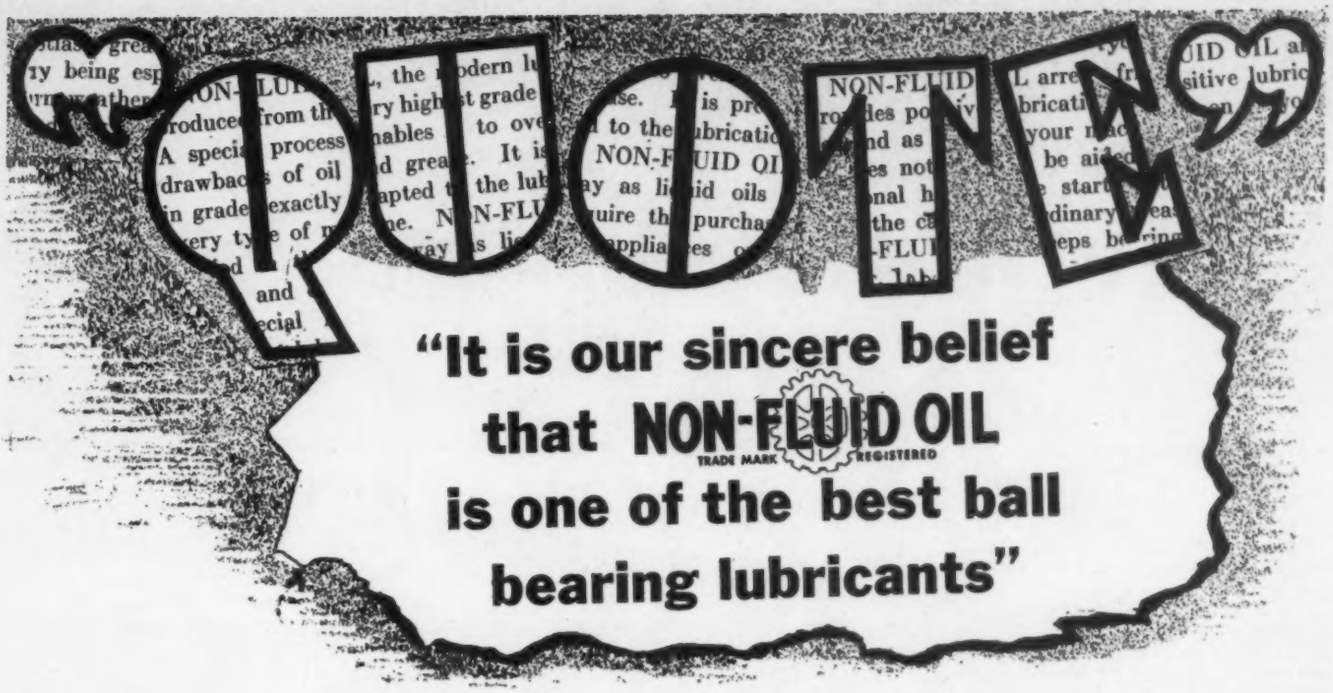
Loftus is fully equipped to handle any furnace construction problem that you may have—however difficult or exacting.

All Loftus furnaces are tailor-made to meet individual requirements. Their sound design and rugged construction insure higher efficiency at lower operating costs.

Inquiries are invited for all types of Industrial Furnaces, Melting and Heating Furnaces and related equipment for the Steel, Foundry, Aluminum and Brass Industries.

610 SMITHFIELD ST. **LOFTUS ENGINEERING** *corporation* PITTSBURGH, PA.

Designers and Builders Engineers, Consultants, Contractors



NON-FLUID OIL is the ideal anti-friction bearing lubricant because it possesses these all-important properties.

(1) NON-FLUID OIL prevents the generation of frictional heat by reducing friction between the balls and rollers and their retainers (sliding friction).

(2) NON-FLUID OIL protects the highly finished surfaces of balls and rollers with a constant film of lubricant to prevent attack by moisture and acid fumes and thus avoid rust and corrosion.

(3) NON-FLUID OIL forms a perfect lubricating seal between the rotating shaft and housing to exclude foreign matter, such as dirt, moisture, etc.

(4) Finally and of great importance, NON-FLUID OIL is strictly neutral and devoid of any tendency to develop free fatty acids. The corrosive action of free acids is even more detrimental than the rust produced by moisture. Many greases which are neutral when made, later decompose and become high in acid or alkaline properties. NON-FLUID OIL possesses exclusive "built-in" characteristics which assure the greatest stability both in USE and in STORAGE.

N. Y. & N. J. LUBRICANT CO., Dept. IS
292 Madison Avenue, New York 17, N. Y.
Please send me testing sample of NON-FLUID OIL to be used in the following machinery:

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Company.....
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City.....State.....

WAREHOUSES:
Atlanta, Ga.—Greenville, S. C.—Charlotte, N. C.—Providence, R. I.—Chicago, Ill.—St. Louis, Mo.—Detroit, Mich.
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CHECK THIS SCOREBOARD

before you buy wire and cable for Severe Service

	INSULATION	HEAT RESISTANCE	AGE RESISTANCE	OIL, GREASE, FUMES	FINAL SCORE
ORDINARY WIRE	?	?	?	?	?
ROCKBESTOS WIRES AND CABLES	IMPREGNATED ASBESTOS INSULATION FOR PERMANENCE	WON'T BAKE BRITTLE, CRACK OR FLOW UP TO 230° F.	TIME DOESN'T DETERIORATE ASBESTOS	INSULATION WON'T ROT, BLOOM SWELL OR BURN	LOWER MAINTENANCE EXPENSE AND LASTING PROTECTION AGAINST CIRCUIT FAILURES AND EQUIPMENT BREAKDOWNS

You get *big league* performance and value for your wire and cable money when you install Rockbestos A. V. C. in trouble-making circuits. Because of their *permanent insulation* of impregnated asbestos, Rockbestos Type AVA wires and cables will take temperatures up to 230° F. *continuously* without baking brittle, cracking or flowing. And for other maintenance-reducing advantages you can cash in on — they won't deteriorate with age; won't rot or bloom when in contact with fumes, grease or oil; and won't burn or carry flame.

A variety of constructions in 600 to 5000 volt ratings includes single and multi-conductor power cables, switchboard and lighting wires, control cables and other National Electrical Code types. Write for catalog, recommendations or samples.

ROCKBESTOS PRODUCTS CORPORATION
195 Nicoll Street, New Haven 4, Conn.

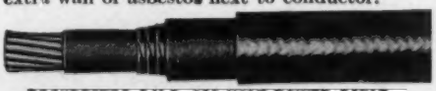
ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

NEW YORK BUFFALO CLEVELAND DETROIT CHICAGO PITTSBURGH
ST. LOUIS LOS ANGELES SAN FRANCISCO SEATTLE PORTLAND, ORE.

ROCKBESTOS A.V.C. 600 VOLT BOILER ROOM WIRE— TYPE AVA

Varnished cambric, impregnated asbestos and a heavy asbestos braid make this wire ideal for lighting and control circuits exposed to heat and moisture or corrosive fumes around furnaces, boilers, lehrs, ovens, soaking pits, etc. Sizes 18 to 8 AWG as above, 6 to 4/0 have extra wall of asbestos next to conductor.



ROCKBESTOS A.V.C. 600 VOLT POWER CABLE— TYPE AVA

Insulated with impregnated asbestos and varnished cambric and covered with asbestos braid, like Rockbestos A.V.C. Motor Lead Cable, this cable withstands high ambient temperatures in power circuits and heat-exposed equipment. Also resistant to oil, grease, moisture and flame. Sizes 18 AWG to 2,000 MCM.

ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE

In one to 19 conductors with individuals insulated like Power Cable above, coded cotton braids, and either asbestos, lead sheath, armor, or lead and armor overall. For permanence under heat and moisture and corrosive fumes. Strandings AWG 12—19/#25 and AWG 9—19/#22. Others on order.

How Many Bearings in Your Plant?

Trabon Lubrication Systems can Save You $5 to $8 per bearing per year!

IT'S a matter of simple arithmetic. Each bearing requires at least one minute per day of your lubricating man's time. At prevailing wage rates you are paying at least 1.7¢ per day for once-a-day lubrication of each bearing. Multiplied by 300 working days a year *each bearing is costing you $5.10 per year in man-hours alone!*

Trabon Centralized Lubricating Systems will put this money back in your pocket. Hundreds of bearings can be lubricated in a few moments' time, positively, accurately. And there are other savings, too. Trabon Systems eliminate "down-time" for lubrication. Machinery is lubricated while it is in operation. Bearing repair bills are slashed. Breakdowns and expensive lost production time are eliminated. Lubricant is used more efficiently. *These savings add up to anywhere from $8 to $10 per bearing per year on the average machine.*

Take an ordinary press with 20 lubricating points. In a year's time—at $8 per bearing—you save at least $160. *At that rate your Trabon System will completely pay for itself in considerably less than two years!*

Trabon Systems are in daily use on blast furnaces, cranes, conveyors, coal crushers, canning and bottling machinery, machine tools, mills, and mill tables, manipulating and handling equipment, ore bridges and unloaders, presses and forging equipment, rubber mills and mixers—in fact anywhere that bearings require systematic lubrication. Let Trabon's generation of experience in industrial lubrication help solve your lubricating problems. Use the attached business reply card for more information on Trabon Positive Centralized Lubricating Systems.

5 WAYS *Trabon* POSITIVE LUBRICATION WILL PUT MONEY IN YOUR POCKET

1. Eliminate Bearing Repair Bills
2. Eliminate Lost Production from Bearing Breakdowns
3. Reduce Lubricating Man-Hours
4. Eliminate "Down-Time" for Lubrication
5. Reduce Lubricant Consumption

Trabon ENGINEERING CORPORATION
1814 EAST 40TH STREET • CLEVELAND 3, OHIO
INDUSTRIAL LUBRICATION EXCLUSIVELY SINCE 1922

Mail this card today, it needs no postage

TRABON ENGINEERING CORPORATION
1814 East 40th Street • Cleveland 3, Ohio

Please send me more information on Trabon Positive Lubricating Systems. I am particularly interested in lubricating

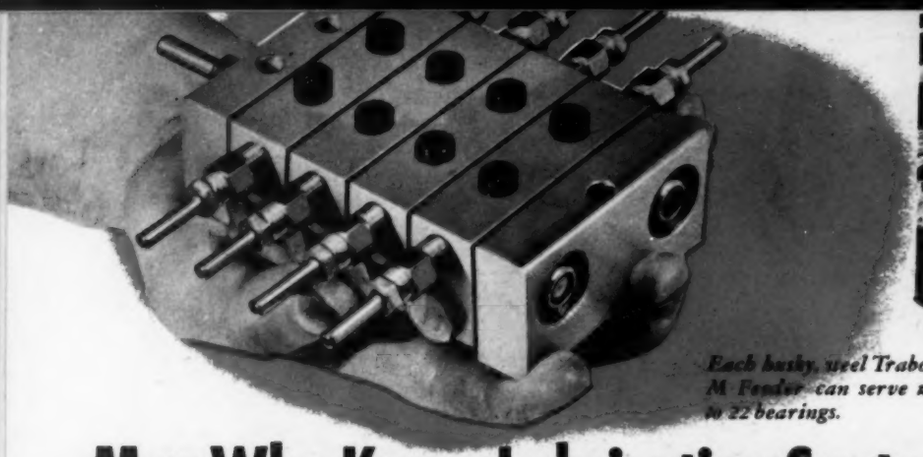
_____

Name _____ Title _____

Company _____

Address _____

City and State _____



Each husky, steel Trabon M Feeder can serve up to 22 bearings.

Men Who Know Lubricating Systems

Specify Trabon

Check these Operating Features and you'll realize why plant engineers and master mechanics prefer Trabon

1. **All-Hydraulic Operation**—Feeder measuring pistons are positively actuated by hydraulic flow of lubricant and do not rely on spring operation.

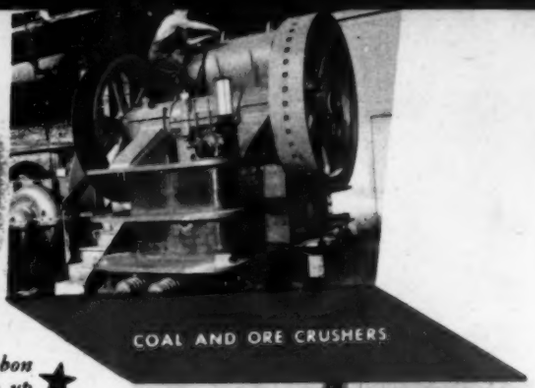
2. **Progressive Operation**—Feeder sections operate progressively, one after the other. Each piston discharges its full measured amount of lubricant before the main hydraulic flow from the pump can reach and operate the next piston. *This makes it impossible to skip or under-lubricate a bearing.*

3. **Only One Indicator to Watch**—The single indicator at the pump tells the whole story, giving positive proof when *every* bearing has received its full measured amount.

4. **Rugged, Steel, Sealed Feeders**—vibration-proof, heavy steel feeders are completely sealed and have no exposed moving parts. The sealed Trabon System can be buried underneath dirt, grime, coal dust or even concealed inside the machinery. For the single indicator at the pump tells the story!

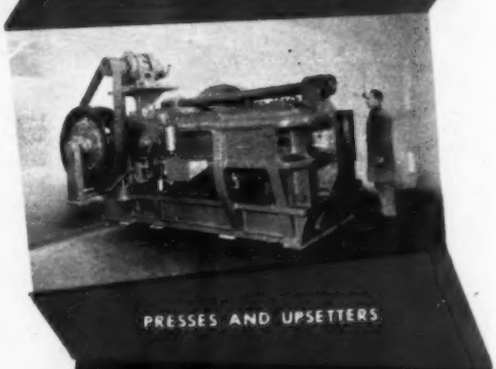
5. **Wide Range of Discharges**—Trabon Feeders can provide extreme variations in lubricant discharges. A complete line of manual and automatic pumps meets the needs of lubricating systems of all sizes and types.

Let Trabon's Generation of Experience
Help Solve Your Lubricating Problems

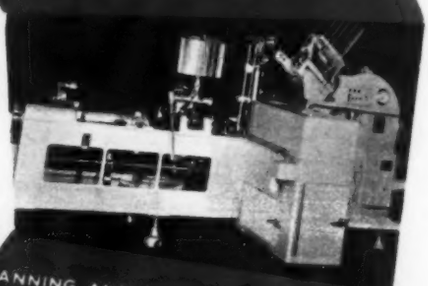


COAL AND ORE CRUSHERS

MACHINE TOOLS

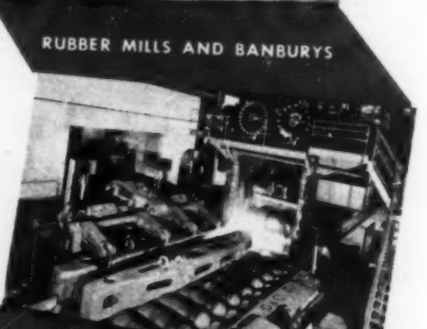


PRESSES AND UPSETTERS



CANNING AND CONTAINER MACHINERY

RUBBER MILLS AND BANBURYS



STEEL MILL EQUIPMENT

FIRST CLASS
PERMIT No. 4736
(Sec. 510, P. L. & R.)
CLEVELAND, OHIO

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2¢ POSTAGE WILL BE PAID BY—

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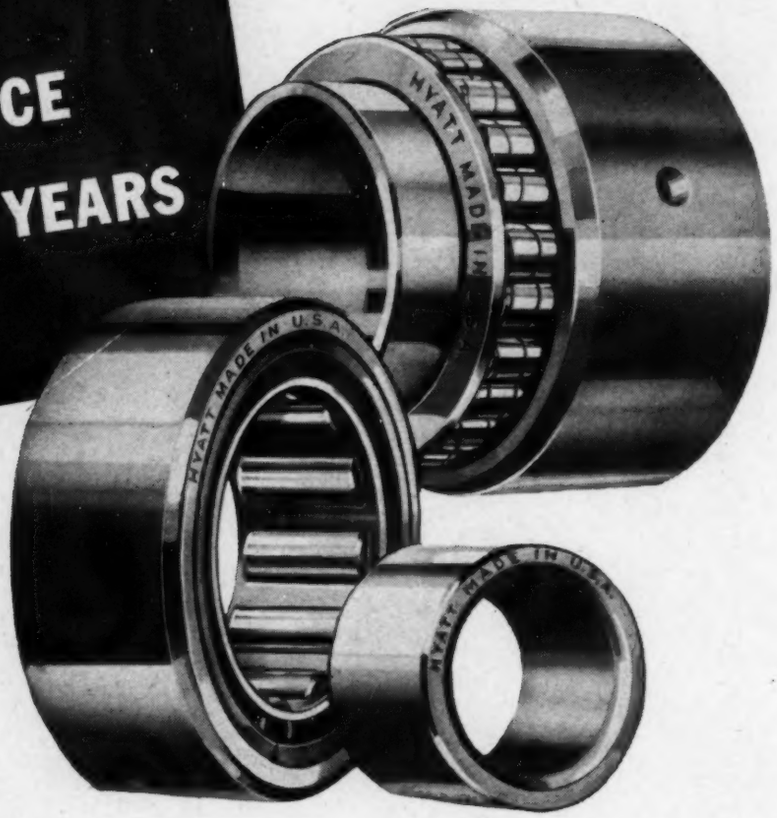
1814 EAST 40TH STREET
CLEVELAND 3, OHIO

Another
STEAM-VACU INSTALLATION
A Model No. 106-XS in a large steel plant located in the Chicago area.
THE VACUUM CONVEYOR COMPANY
MAIN OFFICES: CURREN ARCADE BUILDING, NORRISTOWN, PENNSYLVANIA
SALES REPRESENTATIVES: PHILADELPHIA, PA. PITTSBURGH, PA. GARY, IND.

CARE-FREE BEARING PERFORMANCE THROUGH THE YEARS

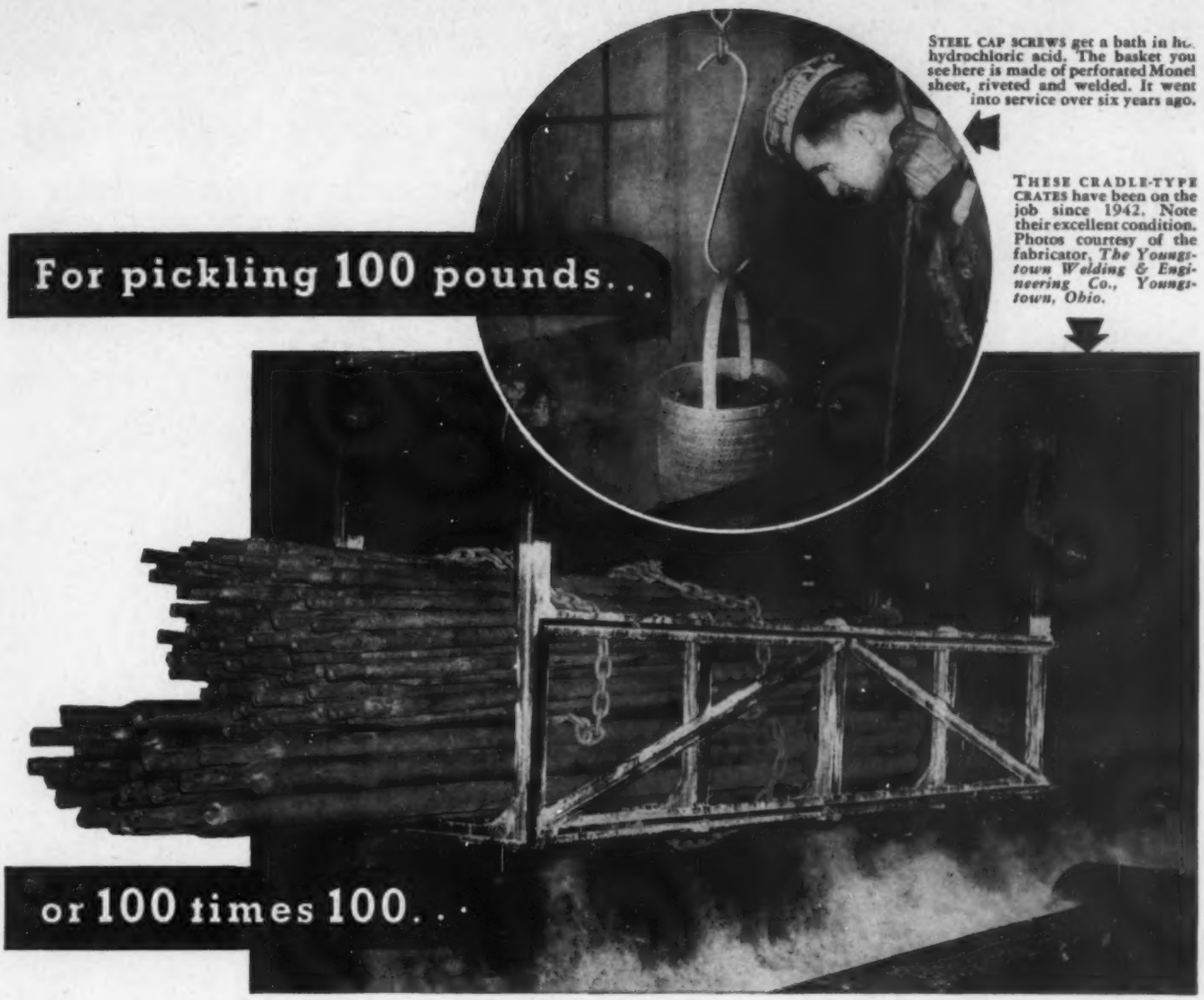


It's been a good many years since the first Hyatt Roller Bearings were applied to heavy steel mill equipment.

And today, carrying heavy loads in tables—cranes—cars—mill motors—as well as miscellaneous equipment, Hyatt Roller Bearings continue to serve and save.

With such long and care-free performance records to recommend them, no wonder Hyatt Roller Bearings are preferred and so widely used. If there is any application data you want, please ask for it. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS



STEEL CAP SCREWS get a bath in hydrochloric acid. The basket you see here is made of perforated Monel sheet, riveted and welded. It went into service over six years ago.

THESE CRADLE-TYPE CRATES have been on the job since 1942. Note their excellent condition. Photos courtesy of the fabricator, *The Youngstown Welding & Engineering Co., Youngstown, Ohio.*

GET THE EXTRA FEATURES OF MONEL

There's no need to pile on ***dead*** weight when you want stronger, longer-lasting baskets or crates.

*Just use Monel**. It has plenty of *extra* strength and toughness. It resists corrosion by sulfuric acid and dilute hydrochloric acid pickling solutions.

With Monel, your equipment doesn't have to be made extra heavy to allow for rapid corrosion. You handle bigger pay loads faster . . . and with *safety*. You save time . . . labor . . . power . . . acid.

You save another way, too. *Even equipment that must be designed for a special job* can be readily fabricated from regular Monel mill forms (rods, bars, angles, etc.) Whatever its form, Monel is readily cut, bent, machined, forged and welded by ordinary methods. Welding doesn't reduce strength, toughness or corrosion resistance.

Remember all these advantages of Monel when a pickling problem has you stumped. Remember also, that experienced fabricators like THE YOUNGSTOWN WELDING & ENGINEERING COMPANY (who made the basket and rack shown above) can offer practical help in design and fabrication.

THE INTERNATIONAL NICKEL COMPANY, INC. *67 Wall Street, New York 5, N. Y.*

EMBLEM OF SERVICE

NICKEL INCO ALLOYS

MONEL*

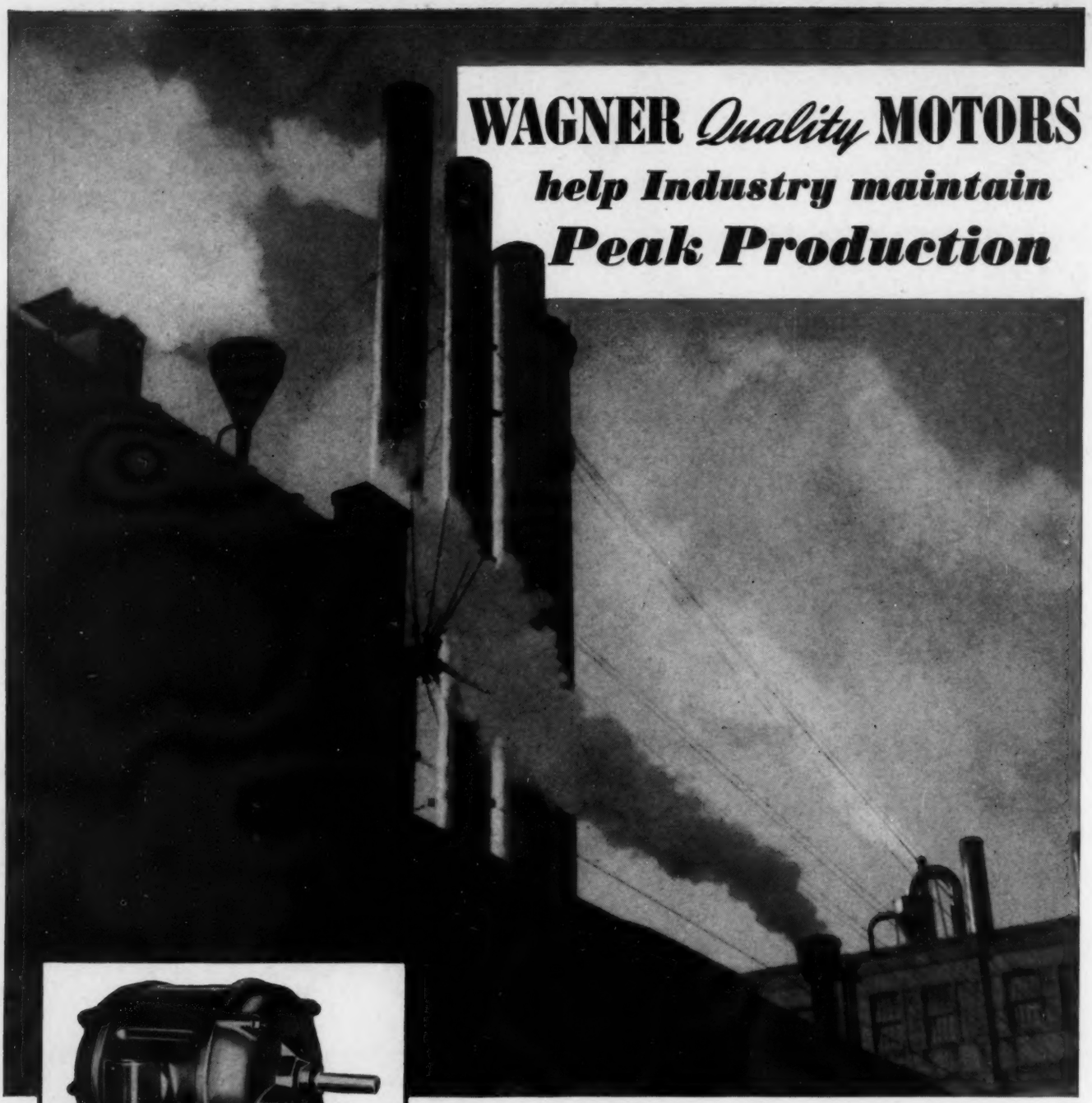
MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL • INCONEL* • NICKEL • "L"* NICKEL • "Z"* NICKEL

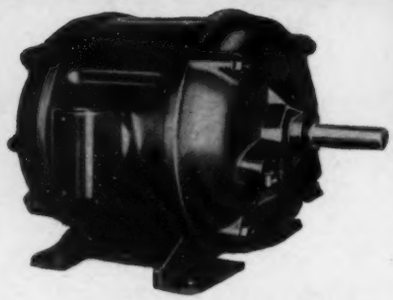
*Reg. U. S. Pat. Of

WAGNER *Quality* MOTORS

help Industry maintain

Peak Production





Regardless of what your motor requirements may be—large motors . . . small motors . . . Wagner makes them all. The motor illustrated is typical of the Wagner line of polyphase and single-phase motors. Choose a Wagner motor for your next installation.

Whistles blow, workers stop, and new shifts come on to the job, but motors driving production equipment must whirl merrily on around the clock to help industry maintain peak production. And peak production can be maintained only if motors stay on the job without breakdowns. Dependable motor performance is a tough assignment—but not so tough for Wagner Motors. They have the stamina to stand up because they are made of highest quality materials and are engineered to do the job efficiently. If you want motors that *will* do the job, whether large or small, contact any of our twenty-nine branches. They are located in principal cities and manned by trained field engineers who will help you solve your motor problems. A letter addressed to Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis 14, Mo., will bring Bulletins on the complete line of Wagner Quality Motors.

Consult Wagner Engineers on all Electric Motor Problems

Wagner Electric Corporation

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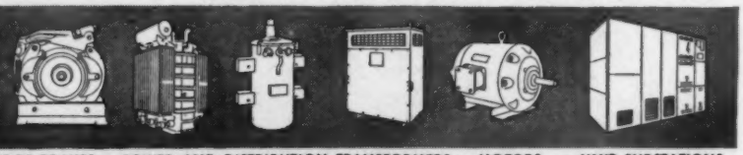

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M47-23

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For application to soaking pits, heating, and other types of metallurgical furnaces.
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SALES ENGINEER
To sell new type heating furnace equipment. Permanent position, good salary. Experience and contacts with forging industry and practice essential. Headquarters Pittsburgh district. State experience, age, other pertinent information in confidential letter to IRON AND STEEL ENGINEER, Box 700, 1010 Empire Building, Pittsburgh 22, Pa.

PLANT SUPERINTENDENT by material handling equipment manufacturer located in Detroit. Should have engineering education and experience in machine work, structural fabricating and welding. Give complete information including age, experience, education and salary expected. Box 701, Iron and Steel Engineer, 1010 Empire Building, Pittsburgh 22, Pennsylvania.

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FIVE LINES MINIMUM CHARGE
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POSITIONS WANTED

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CHRISTMAS IN JULY!
Give the IRON AND STEEL ENGINEER for Christmas. One year's subscription (U.S.) $7.50.

WANTED

Copies of "THE MODERN STRIP MILL" published by the AISE. If your copy is not being used why not sell it? For details write to IRON AND STEEL ENGINEER, BOX 705, 1010 Empire Building, Pittsburgh 22, Pa.

No sag...no drag...Coils ride safely and gently on LINK-BELT Conveyors

Coils that ride the Link-Belt Conveyor make their trip safely. Ample bearing surfaces and sturdy construction prevent the sag and drag that scuff strip edges. Telescoping is eliminated and the reduction in edge damage has a marked effect on scrap losses; accomplishing a reduction in the cost of tin plate production.

Link-Belt conveyors offer carefree operation. Ruggedly built, smooth running, Link-Belt offers designs for handling coils in various positions, allowing complete flexibility in mechanical handling.

Discuss your plans for mill modernization with a Link-Belt Engineer, the man backed by broad experience in your materials handling problems.

SERVICE TO STEEL BY LINK-BELT . .

Complete line of Chains for transfer tables, coil conveyors, furnace conveyors, feeder and catcher tables, sheet pilers, draw bench and other equipment . . . Elevators and Conveyors of all types, such as belt, bucket, screw, flight, Bulk-Flo, drag chain, apron, Sidekar-Karrier, trolley, Oscillating-Trough, etc. . . . Vibrating Screens . . . Dryers and Coolers . . . Skip Hoists . . . Car Dumpers . . . Car Spotters and Haulage Systems . . . Portable Conveyors and Bucket Loaders . . . Traveling Water-Intake Screens . . . Automatic Stokers . . . Silent and Roller Chain Drives . . . Speed Reducers and Increasers . . . Variable Speed Transmissions . . . Sprockets . . . Gears . . . Clutches . . . Couplings . . . Babbitted, Ball and Roller Bearings, etc.

10,281

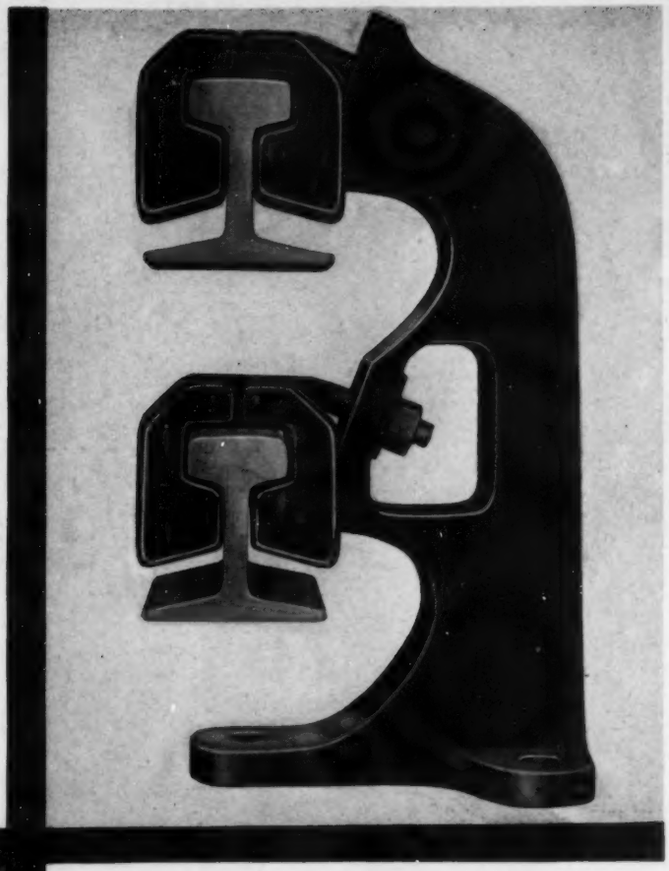
LINK-BELT COMPANY

Chicago 9, Pittsburgh 19, Cleveland 13, Detroit 4, Indianapolis 6, St. Louis 1, Kansas City 6, Mo., Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

rain . . . snow . . . sleet

POSITIVE POWER

under all conditions



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From the heat of furnaces to the outside trackage subject to rain, sleet and snow, Keystone Under-Rail Contact Systems have proved their ability for positive transmission of power.

Keystone Under-Rail Contact System is particularly adaptable to industrial work for use in connection with the operation of heavy cranes, conveyors and industrial haulage systems.

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For long-lasting, positive transmission of power, specify Keystone. For full details on the many other industrial electrical products manufactured by Keystone, write for complete catalog to . . .

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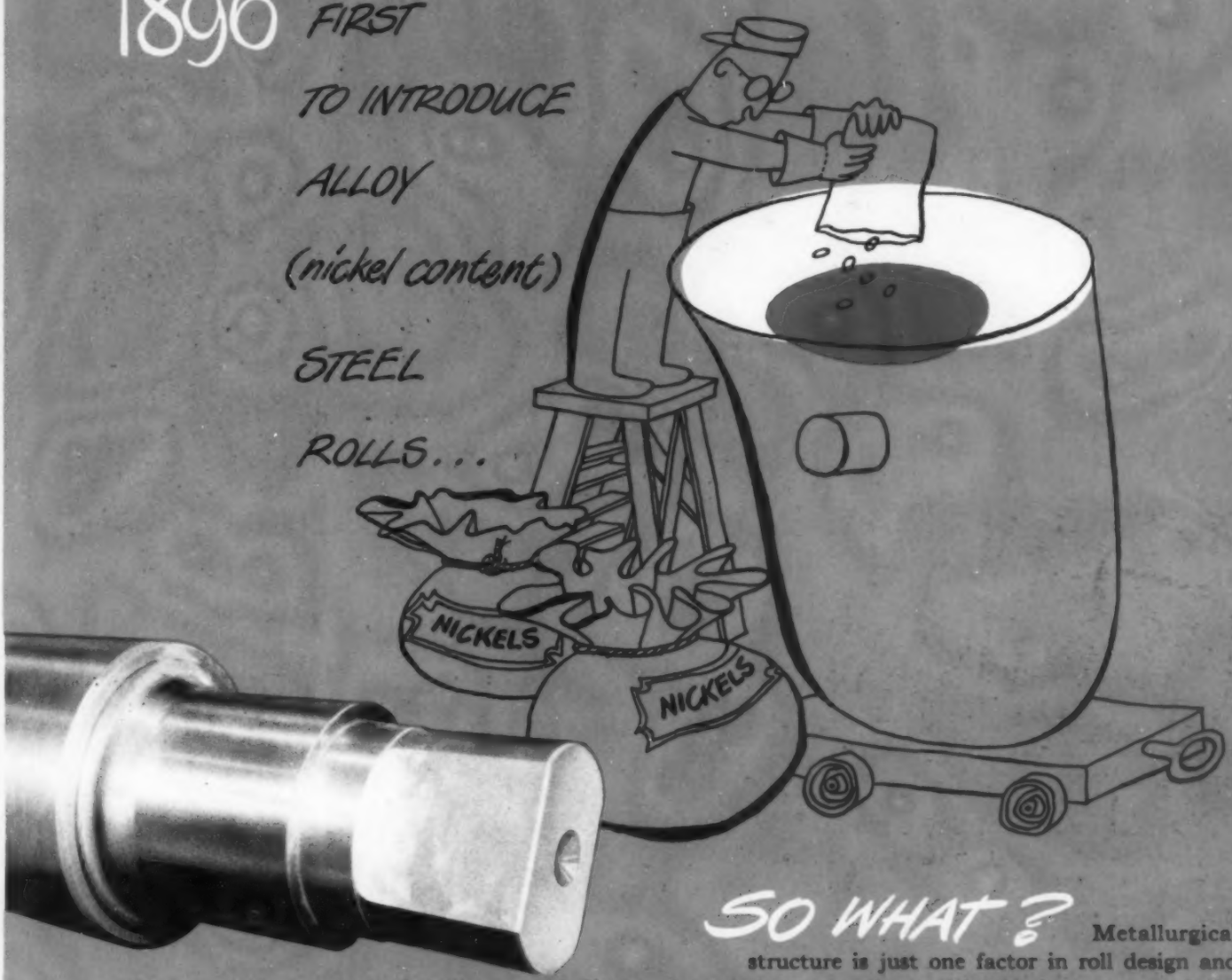


SO WHAT?

Metallurgical structure is just one factor in roll design and manufacture—a subordinate element by comparison with the importance of the rolling-mill operator.

In more than a century of association with metal-rolling we've learned that the skill of the operator in *the proper use of the proper rolls* is the really important factor—we've learned that Mackintosh-Hemphill engineers and metallurgists face a constant challenge to continue the pioneering effort which resulted in Mack-Hemp's introduction of virtually every major roll development.

So that you, as an operator, may achieve the highest standards of excellence in metal-rolling Mackintosh-Hemphill engineers are continuing their study of everyday mill problems, accepting the challenge to develop rolls which will accomplish the most difficult production tasks.

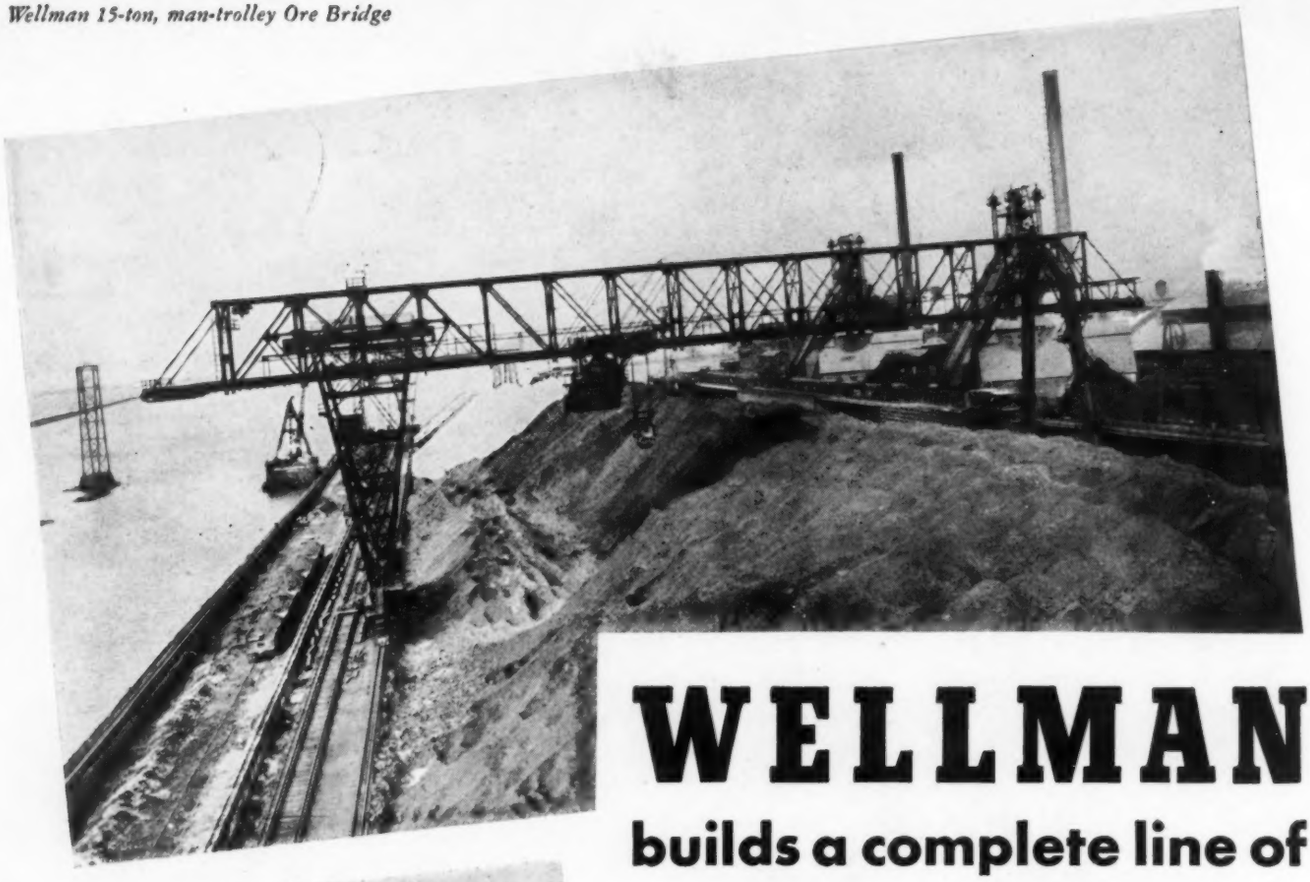
Your contribution of the practical mill know-how to this Mack-Hemp research assures constantly better metal-rolling production with improved Red Wabbler Rolls.

MACKINTOSH-HEMPHILL CO.

Makers of the rolls with the red wabblers

PITTSBURGH & MIDLAND, PA.

Wellman 15-ton, man-trolley Ore Bridge



WELLMAN

builds a complete line of ORE and COAL HANDLING BRIDGES

Wellman 2-ton, Coal Storage Bridge

The Wellman Engineering Company has a wealth of experience in building Ore and Coal Handling Bridges of many types and capacities.

Wellman 7-ton, rope-operated, Coal Storage Bridge with folding boom in elevated position.

★

WELLMAN WILL BUILD IT!

- Car Dumpers (all types)
- Ore and Coal Handling Bridges
- Gas Producers
- Skip Hoists
- Industrial Furnaces
- Coke Pushers
- Mine Hoists
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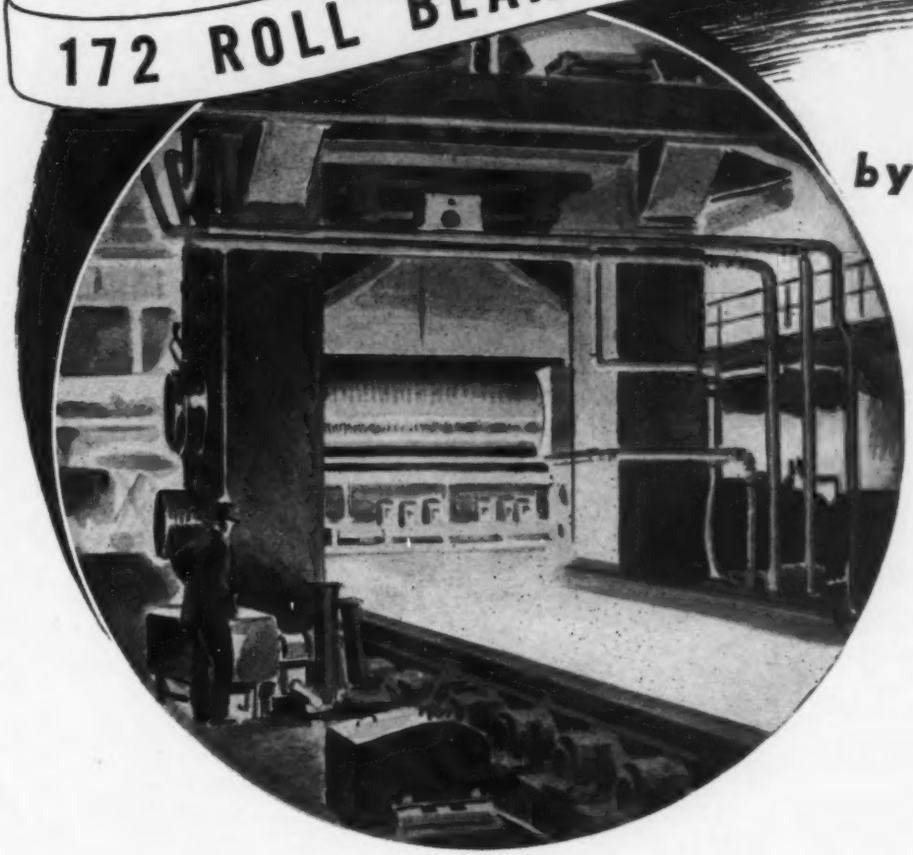
- Soaking Pits

Special Cranes (Wharf, Dry-Dock, Hammerhead, Pontoon)

THE WELLMAN ENGINEERING COMPANY
7031 CENTRAL AVENUE • CLEVELAND 4, OHIO

172 ROLL BEARING CHANGES SAVED



by switching to

N•B•M
#200 BRONZE

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BRONZE AND COPPER CASTINGS

Blast Furnace Copper Castings
Roll Neck Bearings • Slippers
Housing Nuts • Machinery Castings
Babbitt Metals • Acid Resisting Castings • Phosphorized Copper

In 1941 a large plate mill installed a trial pair of N-B-M Top Bearings. Performance was so good they have used nothing but N-B-M Bearings for the past 5 years—68 in all.

During this period, they would have needed 240 bearings from their own foundry at the previous consumption of 4 a month. Net saving: 172 bearing changes—400% more tonnage rolled per set—by switching to N-B-M #200 Bronze!

Aren't such savings worth looking into—right now?

N B M

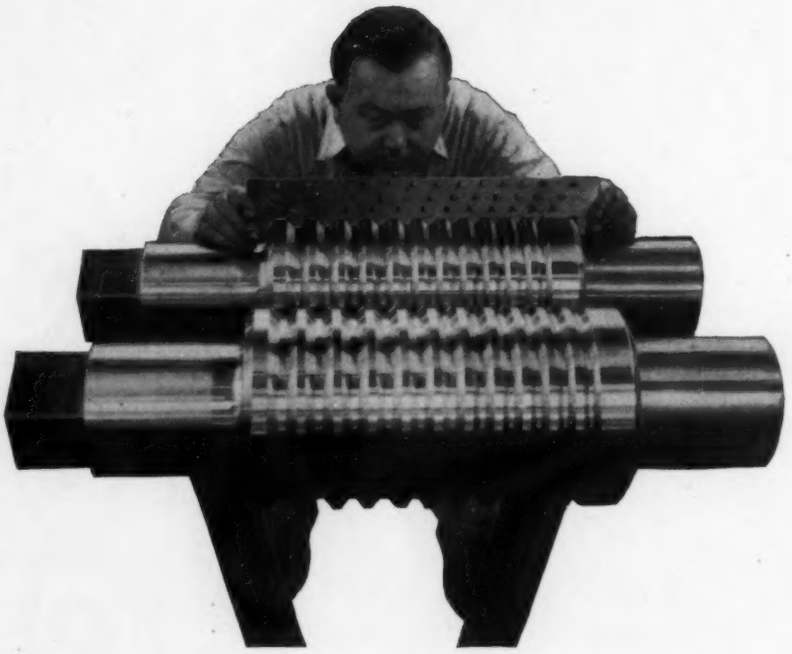
AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION
PITTSBURGH • NEW YORK

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

YOU CAN BANK ON THESE ROLLS

Rolling sheet or strip . . . steels . . . precious metals . . . copper . . . aluminum? Count on Midvale for the right roll for your purpose, whatever it may be. Midvale hardened and ground forged steel rolls are manufactured to meet the specific requirements of our customers. They're custom-made by men accustomed to problems of analysis, hardness, finish, special grinding, etc.—men who have the best of equipment and unusual skill. Forged rolls are a Midvale specialty. They are worthy of your confidence.



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Custom Steel Makers to Industry

STAINLESS AND TOOL STEEL BARS
•
CORROSION AND HEAT RESISTING CASTINGS
•
FORGINGS AND RINGS

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Brutes for Strength

1 ***Greatest Shock Absorbing Capacity*** of any type single-row bearing. Here's the secret: Norma-Hoffmann Precision Roller Bearings provide full line contact between rollers and races. That means you get, size for size, a maximum area to support shock load.

2 ***Handles Up to 50% Overload*** Full line contact, the design feature of these bearings, also provides ample margin for severe temporary overloads.

3 ***Lowest Coefficient of Friction*** under heavy load of any type bearing, plus unsurpassed speedability. These important benefits are a result of Norma-Hoffmann's 100% machined bronze retainer, precision workmanship and short, parallel roller design.

When the going is so tough no other anti-friction bearing will stand up—use Norma-Hoffmann Precision Roller Bearings. You will continue to get dependable service under critically severe conditions of speed, load, shock and vibration. These bearings are precision-made to unusually exacting tolerances and are backed by years and years of proved performance. Norma-Hoffmann Bearings Corporation, Stamford, Conn.

"NORMA-HOFFMANN"

Precision Ball, Roller and Thrust Bearings

FIELD OFFICES: NEW YORK, CHICAGO, CLEVELAND, DETROIT, PITTSBURGH, CINCINNATI, LOS ANGELES, SAN FRANCISCO, PORTLAND, ORE., SEATTLE, PHOENIX

BY ELIMINATING shutdowns formerly required for hand oiling and bearing changes, Farval is helping to speed the output of steel so urgently needed for construction and production.

On one large plate mill, for example, it was possible to increase output from 320 tons to 445 tons per shift by installing a Farval system to provide continuous, adequate lubrication of mill, pinion and table bearings.

Plate production upped 39% with Farval automatic lubrication

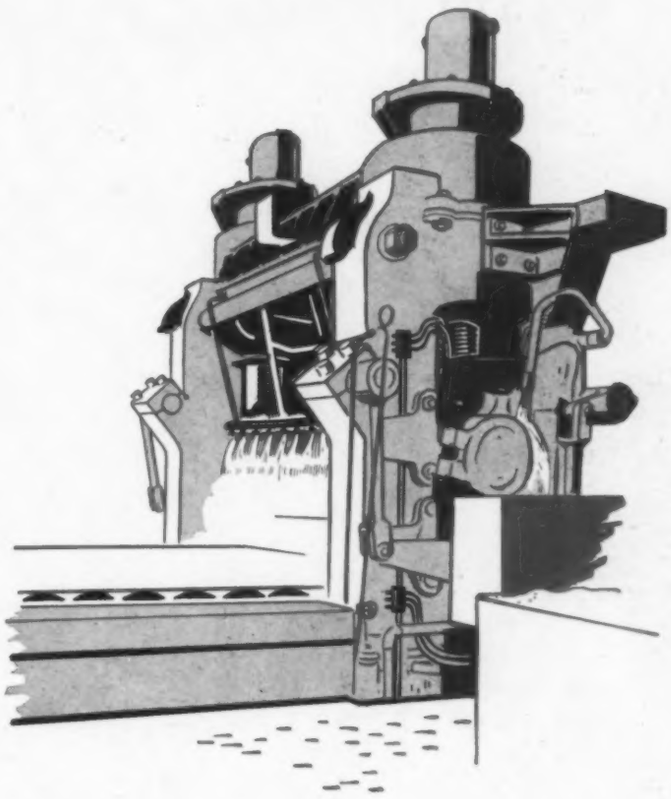
Most of this 125-ton-per-turn increase resulted from eliminating stops for hand oiling. Before Farval, the mill had to shut down every three hours to repack roll necks. Additional tonnage was gained by eliminating the need for frequent bearing changes. When lubricated by hand, top bearings had to be replaced every 2000 tons. Bottom bearing life averaged 4000 tons. Adequate lubrication with Farval increased bearing life from 48 to 55 times. The tabulation tells the story:

Bearing life in tons rolled	Top bearing —average	Bottom bearing — average
Before Farval was installed .	2,000 tons	4,000 tons
After Farval.	96,000 tons	220,000 tons

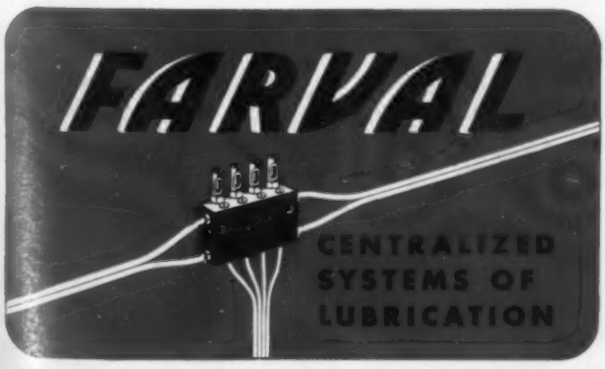
The annual savings in bearing replacement cost was in excess of $100,000. Substantial additional savings were realized in power cost, labor of oiling and lubricant consumption. In fact, the overall lubrication costs throughout the entire mill were reduced 40%.

Farval delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, at regular intervals. Farval is the Dualine System with the Positive Piston Displacement Valve. This valve has but two moving parts and is fully adjustable, with a Tell-tale indicator at each bearing to show the job is done. For a full description of Farval, write for Bulletin 25, The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



FARVAL—*Studies in Centralized Lubrication No. 86*



BEWARE
OF MAD SHORT CIRCUITS...

Protect Your High-voltage Motors with LIMITAMP CONTROL

Limitamp quickly and easily brings these mad short circuits under control. In less than *one-quarter* cycle, Limitamp's EJ-2 fuses cut off a rise in current from a short, and clear it in one-half cycle—long before the fault current has time to harm the contactor or motor. Your plant's power system needs this prompt handling of fault currents, and you will avoid the risk of costly shutdowns that can result from *one mad short circuit.*

A STARTER AND PROTECTOR IN ONE CABINET

G-E Limitamp control consists of an air-break contactor (the motor starter), and EJ-2 fuses (the short-circuit device). They are mounted in separate compartments of one, all-steel cabinet. Air-break contactors are specially designed for hard duty. Operating experience has proved that they furnish dependable, long-lived, low-cost service with only routine inspection.

Because they operate in air, they eliminate the problem of handling oil. And tip life of air-break contactors is many times that of comparable oil-immersed tips.

EJ-2 fuses are easy to replace, and they can't wear out. When you install a new fuse, you know your short-circuit protective device is in perfect condition.

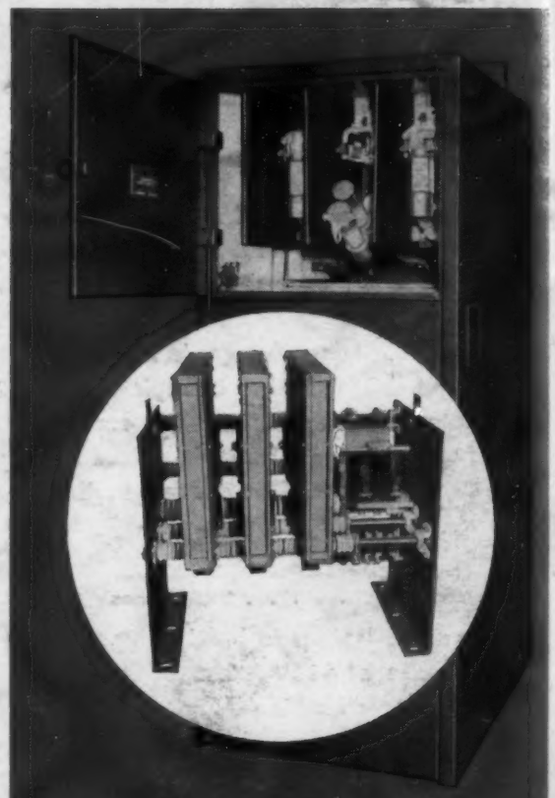
OVERLOAD AND UNDERVOLTAGE PROTECTION

Isothermic overload relays, accurately calibrated against actual motor characteristics, guard the motor against overheating from sustained loads or single phasing.

FACTORY-ASSEMBLED CONTROL

Factory-assembled in one cabinet, Limitamp is easy to install, easy to co-ordinate with other control, saves space, and improves the appearance of your plant.

GENERAL ELECTRIC



Limitamp control is furnished as a single unit, in groups, or in special enclosures for special operating conditions.

The Trend is to
AIR

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